Том 3, № 2 Volume 3, Number 2 2012

СОЦИОЛОГИЯ НАУКИ И ТЕХНОЛОГИЙ ТОМ 3 № 2 2012

# СОЦИОЛОГИЯ
## науки и технологий

## Sociology of Science & Technology

Санкт-Петербург

РОССИЙСКАЯ АКАДЕМИЯ НАУК

САНКТ-ПЕТЕРБУРГСКИЙ ФИЛИАЛ
ИНСТИТУТА ИСТОРИИ ЕСТЕСТВОЗНАНИЯ И ТЕХНИКИ
им. С. И. ВАВИЛОВА

ИЗДАТЕЛЬСТВО «НЕСТОР-ИСТОРИЯ»

# СОЦИОЛОГИЯ НАУКИ И ТЕХНОЛОГИЙ

**2012**

**Том 3**

**№ 2**

Санкт-Петербург

Журнал издается под научным руководством Санкт-Петербургского филиала Института истории естествознания и техники им. С. И. Вавилова Российской академии наук
**Учредитель:** Издательство «Нестор-История»
**Издатель:** Издательство «Нестор-История»
ISSN 2079–0910

Журнал основан в 2009 г. Периодичность выхода — 4 раза в год. Свидетельство о регистрации журнала ПИ № ФС77–36186 выдано Федеральной службой по надзору в сфере массовых коммуникаций, связи и охраны культурного наследия 7 мая 2009 г.

**Адрес редакции:**
199034, г. Санкт-Петербург, Университетская наб., д. 5
**Тел.**: (812) 328-59-24. **Факс:** (812) 328-46-67
E-mail: school_kugel@mail.ru
http://ihst.nw.ru

Выпускающие редакторы номера: Н. А. Ащеулова, В. М. Ломовицкая
Редактор русскоязычных текстов: С. А. Душина
Корректор: Н. В. Стрельникова
Подписано в печать: 20.02.2012
Формат 70×100/16. Усл.-печ. л. 9
Тираж 300 экз. Заказ № 2580
Отпечатано в типографии «Нестор-История», 198095, СПб., ул. Розенштейна, д. 21



The Russian Academy of Sciences
Institute for the History of Science and Technology
named after Sergey I. Vavilov, St Petersburg Branch

Publishing House “Nestor-Historia”

# SOCIOLOGY OF SCIENCE AND TECHNOLOGY

**2012**

**Volume 3**

**Number 2**

St Petersburg

The journal is published under the scientific guidance of the Institute for the History of Science and Technology named after Sergey I. Vavilov, St Petersburg Branch, Russian Academy of Sciences. The founder: Publishing House "Nestor-Historia"

**The founder:** Publishing House "Nestor-Historia"
**The publisher:** Publishing House "Nestor-Historia"
ISSN 2079-0910

The journal was founded in 2009. It is a periodical, published 4 times a year in Russia. The journal's certificate of registration PI № FC 77-36186 was given by the Federal Service of supervision in the sphere of mass communications, relations and the protection of cultural heritage on May, 7th, 2009.

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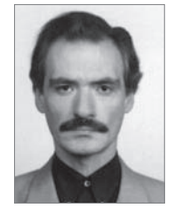

ведущий инженер, системный администратор и администратор сайтов ЦИПИН, ученый секретарь межотраслевой лаборатории МОН Украины и НАН Украины по проблемам формирования и реализации научно-технической политики Украины, Киев, Украина
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## Центр науковедения в Украине


В 2011 году исполнилось 25 лет со времени основания Центра исследований научно-технического потенциала и истории науки (ЦИПИН) им. Г. М. Доброва НАН Украины (1986) и 20 лет со дня предоставления ему статуса самостоятельного академического института (1991). В статье рассказано о формировании и современном состоянии Центра, с которым неразрывно связано развитие науковедения в Украине.

***Ключевые слова:*** наука, науковедение, история науки, Центр исследований научно-технического потенциала и истории науки (ЦИПИН) им. Г. М. Доброва

Науковедческие исследования в Украине начали активно развиваться с 60-х годов XX века. Одним из импульсов активизации интереса к науковедению стало чествование мировым научным сообществом в 1964 году 25-летнего юбилея книги Дж. Д. Бернала «*The social function of science*» (Bernal, 1939). Тогда же был издан международный сборник «*The science of science: society in the technological age*» (1964), посвященный этому юбилею. Спустя два года вышли новые издания этого сборника на английском и русском языках: «*The science of science*» (1966) *и «Наука о науке»* (1966). Его авторы (в том числе такие крупные ученые, как П. М. Блэкетт, П. Л. Капица, С. Ф. Пауэлл, Р. Л. Синг, Ч. П. Сноу, Д. Дж. де Солла Прайс и сам Дж. Д. Бернал) подвели итог начального этапа формирования науковедения.

1966 год стал переломным в процессе становления науковедения в Украине и Советском Союзе. В мае этого года журнал *«Вопросы философии»* опубликовал статью С. Р. Микулинского и Н. И. Родного (1966) *«Наука как предмет специального исследования (к формированию "науки о науке" — науковедения)»,* а в июне во Львове и Ужгороде по инициативе выходца из Украины Семена Романовича Микулинского (в дальнейшем — директора московского Института истории естествознания и техники АН СССР) и польского физика и науковеда академика Польской академии наук Игнация Малецкого был проведен *Советско-польский симпозиум по проблемам комплексного изучения развития науки*.

В том же 1966 году была опубликована первая в Советском Союзе монография по науковедению — книга Г. М. Доброва «Наука о науке. Введение в общее наукознание» (Добров, 1966), в которой представлена концепция развития науковедения как комплексной науки, охватывающей широкий спектр вопросов организации, планирования и управления в области науки.

Тогда же по инициативе Г. М. Доброва состоялся *I Киевский симпозиум по науковедению и научно-техническому прогнозированию,* ставший первенцем в ряду Киевских симпозиумов по науковедению, которые приобрели международный статус и признание и регулярно проводятся один раз в два года, несмотря на все социально-экономические сложности[1].

Творчество доктора экономических наук, профессора, члена-корреспондента АН УССР (1988), члена-корреспондента Международной академии истории науки (Париж, 1965), члена Международной академии гуманитарных и естественных наук (Берн, 1978) Геннадия Михайловича Доброва (1929–1989) имело определяющее значение для формирования науковедения в Украине и в существенной мере во всем Советском Союзе и мире.

Монография «Наука о науке» (1966) стала основой докторской диссертации Г. М. Доброва (1967). Она выдержала еще два расширенных издания в Советском

[1] В июне 2011 г. состоялся внеочередной XXIV Киевский Международный симпозиум «Инновационная политика и законодательство в Европейском Союзе и Украине: формирование, опыт, направления сближения». В октябре 2012 года состоится юбилейный XXV Киевский международный симпозиум по науковедению и истории науки. Материалы Симпозиума будут размещены на сайте www.kissteps.ho.ua.



Союзе (1970, 1989), была переиздана во многих странах и получила мировое признание. Поднятые в ней вопросы Г. М. Добров и его сотрудники развили в ряде других монографий: *«Актуальные проблемы науковедения»* (Добров, 1968), *«Машинные методы переработки историко-научной информации»* (Добров, Смирнов, Клименюк, 1969) *«Потенциал науки»* (Добров, Клименюк, Смирнов, Савельев, 1969), *«Прогнозирование науки и техники»* (Добров, 1969). *«Организация науки»* (Добров, Клименюк, Одрин, Савельев, 1970), *«Управління наукою»* (Добров, Клименюк, Самойлов, 1971), *«Наука: информация и управление»* (Добров, Коренной, 1977), *«Научно-технический потенциал: структура, динамика, эффективность»* (Добров, Тонкаль, Савельев, Малицкий, 1987) и др.

Вклад Г. М. Доброва в становление науковедения как самостоятельной области науки, в формирование информационного подхода к изучению науки, в разработку машинных и математических методов исследования развития науки и техники, в методологию исследования научно-технического потенциала, в развитие научно-технического прогнозирования, в историю науки и другие направления науковедения является уже общепризнанным. Научное наследие ученого составляет около 600 публикаций — монографий, статей в научных журналах и сборниках, докладов на конференциях, публикаций в научно-популярных изданиях, рецензий, переизданий его трудов на других языках.

Многочисленные ученики Г. М. Доброва из разных регионов Советского Союза составили основу широко известной в мире *Киевской школы науковедения*. К моменту институализации этой школы в качестве самостоятельного научно-исследовательского института Г. М. Добров, его ученики и соратники получили результаты мирового уровня по разработке теории научно-технического потенциала и методов его оценки, разработали оригинальные подходы к исследованию вопросов научно-технического прогнозирования и формирования научно-технической политики, выдвинули и обосновали концепцию науковедения как комплексной науки, результаты которой должны широко применяться в социально-экономической практике, разработали программу проведения науковедческих исследований, нацеленную на решение проблем формирования качественного научного потенциала и его использования.

В 1970 году Г. М. Добров стал основателем и главным редактором периодического межведомственного сборника научных трудов *«Науковедение и информатика»*, который в 1993 году был преобразован в ежеквартальный международный журнал *«Наука и науковедение» («Наука та наукознавство», "Science and Science of Science").*

Создание Г. М. Добровым Центра исследований научно-технического потенциала и истории науки АН УССР и последующее предоставление ему статуса самостоятельного академического института НАН Украины означало завершение процесса институализации в Украине научных исследований, объектом которых является сама наука. Долгий нелинейный путь к этому длился, по крайней мере, четверть столетия.

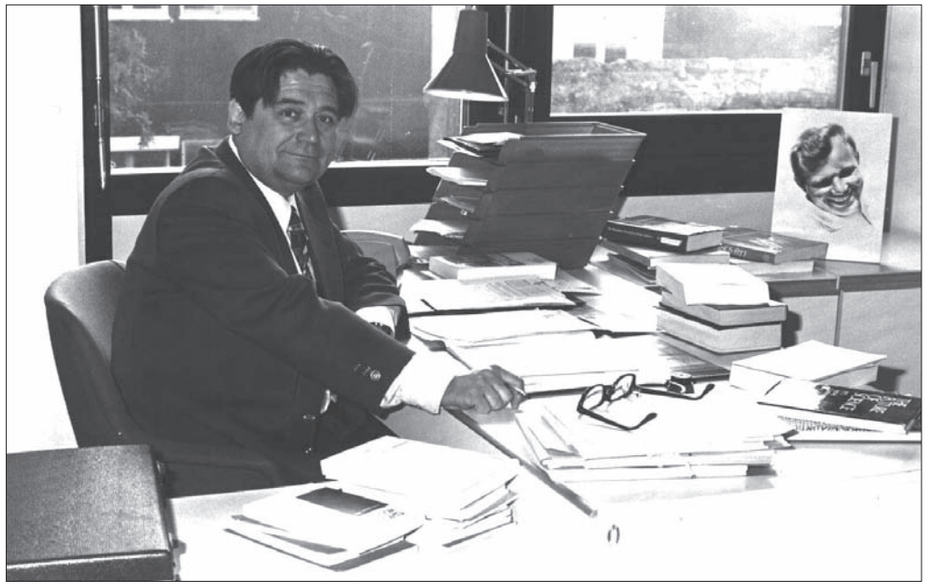
Киевский коллектив науковедов начал формироваться в 1960-х годах в *Институте истории АН УССР* под руководством Г. М. Доброва. Очень важным стал 1966 год, когда Г. М. Добров возглавил отдел машинных методов обработки историко-научной информации этого института. В марте-апреле 1968 года этот коллектив стал Отделением комплексных проблем науковедения и информатики *Института математики АН УССР.* В 1969–1971 годах это уже одноименное подразделение

*Совета по изучению производительных сил УССР (СОПС УССР) АН УССР*; с 1971 по 1984 год — Отделение комплексных проблем науковедения *Института кибернетики АН УССР*; с 1984 по 1986 год — Центр исследований научно-технического потенциала в составе СОПС УССР АН УССР.

Каждый из названных предварительных этапов становления Центра имел принципиальное значение.

В Институте истории АН УССР сформировался *историко-научный подход к науковедческим проблемам*. Характерно, что в первом издании *«Науки о науке»* науковедение охарактеризовано Г. М. Добровым как *«новое направление историко-научных исследований»* (Добров, 1966: 2). В дальнейшем трактовка Г. М. Добровым отношения науковедения к истории науки изменилась. В третьем издании названой книги автор отметил, что науковедение *«существенно переросло рамки своей колыбели — истории науки и техники»*, хотя и сохраняет с ней глубокие связи (Добров, 1989: 28).

Пребывание коллектива науковедов в составе Института математики АН УССР, а затем — Института кибернетики АН УССР, создало благоприятные условия для развития *информационного подхода к анализу науки*, который отличает уже первые науковедческие труды Г. М. Доброва и всей Киевской школы науковедения. К этим исследованиям проявлял глубокий интерес директор Института кибернетики академик Виктор Михайлович Глушков, заместителем которого по научной работе был Г. М. Добров. Совместно с В. М. Глушковым Г. М. Добров опубликовал ряд широко известных трудов (Глушков, Добров, 1969; Глушков, Добров, 1973; Глушков, Добров, Терещенко, 1974; Glushkov, Dobrov, Yershov, Maksimenko, 1978).



Основатель Центра исследований научно-технического потенциала
и истории науки НАН Украины Геннадий Михайлович Добров



Последующее пребывание Центра исследований научно-технического потенциала в составе Совета по изучению производительных сил УССР, заместителем председателя которого являлся Г. М. Добров, позволило киевским науковедам сосредоточить внимание на экономических аспектах науковедения, прежде всего на исследовании *научно-технического потенциала* и изучении *науки как производительной силы,* — на вопросах, огромное значение которых в свое время подчеркивал академик В. И. Вернадский.

С точки зрения процесса институализации науковедения Украины, важным, хотя и неожиданным этапом стало пребывание Центра исследований научно-технического потенциала и истории науки АН УССР с 1986 по 1991 год в составе *Института сверхтвердых материалов АН УССР* в качестве отдельного науковедческого и историко-научного подразделения.

Двадцать пять лет тому назад Президиум АН УССР издал *Постановление № 313* «*О дальнейшем развитии в АН УССР исследований теоретических и прикладных проблем организации науки и истории естествознания и техники» от 22.07.1986,* в котором была подчеркнута необходимость комплексного изучения закономерностей развития науки и техники. Этим Постановлением на базе Центра исследований научно-технического потенциала СОПС УССР АН УССР и Сектора истории естествознания и техники Института истории АН УССР был создан Центр исследований научно-технического потенциала и истории науки АН УССР в структуре Института сверхтвердых материалов АН УССР. Объединение науковедческих и историко-научных исследований и соответствующих научных подразделений стало следствием значительных организационных усилий Г. М. Доброва.

Теоретико-методологические исследования опыта развития науки и техники и обоснование путей усовершенствования организации и управления научно-техническим потенциалом были определены названным Постановлением в качестве *приоритетных* для АН УССР направлений фундаментальных и прикладных исследований. Г. М. Добров был назначен руководителем Центра и заместителем директора Института сверхтвердых материалов АН УССР академика Н. В. Новикова. Общее руководство деятельностью Центра было возложено на вице-президента АН УССР академика К. М. Сытника. Центр был определен главным научно-исследовательским подразделением *Проблемной комиссии «Основные направления развития науки» Межведомственного научного совета по проблемам научно-технического и социально-экономического прогнозирования при Президиуме АН УССР и Госплане УССР.*

Г. М. Добров руководил созданным им Центром до последних дней своей жизни. Особое внимание в это время он уделял вопросам научно-технической политики, эффективности научной деятельности и развитию научно-технического потенциала, что нашло отражение в данном им определении науковедения: *«Науковедение — это комплексное исследование и теоретическое обобщение опыта функционирования социальных систем в науке с целью обоснования научно-технической политики, а также рационального формирования потенциала науки и повышения эффективности научной деятельности с помощью средств социального, экономического и организационного воздействия»* (Добров, 1989: 26).

В 1989 году Центру присвоено имя Г. М. Доброва. Из уважения к основателю вместо полного названия Центр обычно называют просто *Центром Доброва*.

С 1990 года руководителем, а затем директором Центра является заслуженный деятель науки и техники Украины, доктор экономических наук, профессор Б. А. Малицкий.

1989–1991 годы — время становления Центра как самостоятельного научно-исследовательского института. Авторитет, которым пользовался Центр, стал причиной того, что руководители ряда научных учреждений предлагали перевести в свои институты отдельные научные отделы Центра. В этом проявлялось признание достижений, но одновременно это создавало угрозу распада Центра, создававшегося предыдущую четверть века. Ситуация обострялась тем, что Государственный комитет по науке и технике при Совете министров СССР в лице заместителя председателя В. А. Михайлова предлагал перевести Центр в союзное подчинение.

Против таких сценариев развития выступил Президент АН Украины академик Б. Е. Патон, позиция которого определялась однозначно: необходимо сохранить целостность Центра в пределах Украинской академии наук.

Осуществлению этой цели и превращению Центра в самостоятельный научно-исследовательский институт, а тем самым и окончательной институализации украинского науковедения, особо содействовали директор Института сверхтвердых материалов АН УССР академик Н. В. Новиков и вице-президент АН УССР академик К. М. Сытник, которые весной 1991 года направили соответствующее письмо-заявление президенту Академии Б. Е. Патону.

В этом письме, текст которого опубликован[2], было обосновано, что к 1991 году Центр фактически стал самостоятельным научным учреждением. В письме дана высокая оценка вклада коллектива Центра в правдивую реконструкцию развития естествознания и техники, подчеркнуто лидирующее положение Центра в области анализа, оценки и прогнозирования развития научно-технического потенциала страны, отмечена практическая важность этих исследований, в частности, для формирования государственной научно-технической политики. Отмечены широкие международные связи Центра, в том числе длительное плодотворное сотрудничество с ЮНЕСКО. Подчеркнута большая заслуга Центра в подготовке научных кадров в области науковедения и истории науки. Отмечена его активная издательская деятельность. *«Поэтому,* — был сделан вывод, — *необходимо утвердить практически сложившийся статус Центра как самостоятельного научного учреждения при Президиуме АН УССР. Это предложение продиктовано также и необходимостью более эффективного использования опыта и потенциала Центра в интересах решения актуальных проблем научно-технического развития нашей республики: анализа, оценки и разработки рекомендаций по реорганизации науки в республике, по научно-методическому обеспечению реализации новой концепции развития Академии наук УССР. Считаем, что, получив новый статус, коллектив Центра сможет сделать качественный скачок в своей творческой деятельности»*[3].

В соответствии с *Постановлением № 128 Президиума Академии наук УССР «Об изменении статуса Центра исследований научно-технического потенциала и истории науки им. Г. М. Доброва АН УССР» от 08.05.1991*, которое стало ответом на названное обращение академиков Н. В. Новикова и К. М. Сытника, Центр получил статус самостоятельного научного учреждения на правах научно-исследовательского института в составе Отделения информатики, вычислительной техники и автоматизации АН УССР (ныне — Отделение информатики НАН Украины).

[2] *Маліцький Б. А., Кавуненко Л. П., Красовська О. В., Пилипенко О. П.* Форпост українського наукознавства // Вісник НАН України. 2011. №10. С. 36–43.

[3] Там же. С. 40–41.



После обретения Центром статуса самостоятельного института произошло существенное изменение и расширение методологических подходов и направлений исследований Центра. Ведь практически вся история Центра как самостоятельного института приходится на качественно новый исторический период — годы независимости Украины.

В соответствии с *Постановлением № 128 Президиума Академии от 08.05.1991* и в его развитие главным заданием Центра является проведение научно-исследовательских, прогнозно-аналитических и учебно-методических работ по таким основным направлениям: 1. Обобщение исторического опыта, тенденций, закономерностей, социальных проблем развития науки в Украине в контексте развития мировой науки. 2. Разработка организационных, экономических и информационных механизмов формирования и эффективного использования научно-технологического и инновационного потенциалов страны, интеграции отечественной науки в европейскую и мировую научные системы. 3. Разработка научно-технологических и инновационных прогнозов. 4. Анализ опыта, состояния и перспектив развития НАН Украины, ее роли в современном обществе.

В настоящее время Центр проводит теоретические и прикладные исследования и разработки в области истории, теории и организации науки, продолжая традиции

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украинской школы науковедения и развивая новые направления в ответ на требования времени. В частности, Центр активно занимается разработкой и усовершенствованием организационных, экономических и информационных механизмов интеграции отечественной науки в европейскую и мировую научные системы; исследованием факторов трансформации научных систем стран с переходной экономикой, проблемами инновационного развития экономики, разработкой инновационных прогнозов, форсайтными исследованиями и проблемами научной политики. Качественно новые возможности получили и исследования в традиционных направлениях, в частности историко-научные исследования, которые привели к пересмотру многих представлений, существовавших ранее, особенно в области социальной истории науки.

Современная структура Центра также образовалась после обретения им статуса института. Сейчас в составе Центра функционируют 5 научных отделов и межотраслевая лаборатория:

*Межотраслевая лаборатория Министерства образования и науки, молодежи и спорта Украины и Национальной академии наук Украины по проблемам формирования и реализации научно-технической политики Украины*. Заведующий — заслуженный деятель науки и техники Украины, доктор экономических наук, кандидат физико-математических наук, старший научный сотрудник А. С. Попович. Сайт лаборатории: www.foresight.ho.ua.

*Отдел истории науки и техники*. Заведующий — доктор физико-математических наук, профессор Ю. А. Храмов.

*Отдел методологии и социологии науки*. Заведующий — доктор философских наук, профессор В. И. Оноприенко.

*Отдел системных исследований научно-технологического потенциала*. Заведующий — доктор экономических наук, старший научный сотрудник И. Ю. Егоров.

*Отдел проблем инновационного развития экономики*. Заведующий — заместитель директора Центра, доктор экономических наук, кандидат технических наук, профессор В. П. Соловьев.

*Отдел проблем деятельности и стратегии развития НАН Украины*. Заведующий — кандидат технических наук О. А. Грачев.

Наиболее важным вкладом Центра в мировое науковедение является разработка теоретических основ формирования и оценивания научно-технического потенциала, обоснование путей его трансформации в условиях радикальных социально-экономических изменений и усиления роли науки и технологического применения ее результатов в повышении инновативности экономики.

Иногда Центр исследований научно-технического потенциала и истории науки им. Г. М. Доброва НАН Украины сокращенно называют *Центром науковедения*. Но полное название имеет глубокий смысл, ибо подчеркивает не только *объект*, но и один из мощных *методов* исследования науки и технологий, а именно исследование их потенциала. Составляющими научно-технологического потенциала при организационном подходе к этому понятию являются, в частности, кадры, технологическое оснащение, информационное обеспечение, организация исследований и разработок. На ином уровне понятие потенциала охватывает все неиспользованные возможности науки и технологии на определенном этапе их развития. Каждое развивающееся научное направление имеет неиспользованный потенциал, а реализация потенциала — это и есть процесс развития. Поэтому научно-прогностические



и форсайтные разработки также могут рассматриваться как аспект исследования научно-технологического потенциала. Ведь будущее доступно исследованию не непосредственно, а только через познание современного и прошлого и изучение их потенциала.

Кроме проведения собственных исследований, Центр выполняет функции методологического, научно-организационного, прогнозно-аналитического и учебно-методического учреждения, которое координирует исследования и разработки в области науковедения и истории науки и техники, проводимые иными научными учреждения и вузами, предоставляет им научно-методическую помощь в проведении исследований и в подготовке научных кадров.

Центр работает в тесном контакте с министерствами, ведомствами, научными учреждениями, предприятиями, организациями Украины.

Центр исследований научно-технического потенциала и истории науки им. Г. М. Доброва НАН Украины — уникальный междисциплинарный коллектив, в котором работают представители многих научных специальностей, охватывающих широкий спектр фундаментальных направлений естествознания, точных, технических и общественных наук. Сейчас в Центре работает 75 человек, включая 62 научных сотрудника, в том числе 10 докторов и 36 кандидатов наук.

Молодые ученые и аспиранты Центра принимают участие в конкурсах на получение персональных стипендий для молодых ученых, премий имени выдающихся ученых, грантов Президента Украины, кабинета министров Украины и др. Сейчас в Центре работают и учатся 2 стипендиата Президента Украины и 3 стипендиата НАН Украины. Для Центра остается актуальным вопрос развития кадрового потенциала и создания более благоприятных условий для его эффективного использования.

В Центре действуют два специализированных ученых совета по защите докторских и кандидатских диссертаций: *Специализированный ученый совет Д 26.189.01 по экономическим наукам по специальности 08.00.03 — «Экономика и управление национальным хозяйством»* и *Специализированный ученый совет Д 26.189.02 по историческим наукам по специальности 07.00.07 — «История науки и техники»*.

Кроме Киевских международных симпозиумов по науковедению и научно-техническому прогнозированию Центр регулярно проводит другие научные конференции, в том числе международного уровня.

С 1989 года — *Добровские чтения*, ежегодные научные конференции, посвященные памяти основателя украинской науковедческой школы, первого руководителя Центра Геннадия Михайловича Доброва. С 2001 года материалы конференций публикуются в приложении к журналу «*Наука и науковедение*» или отдельными сборниками. Очередные чтения состоятся в марте 2012 года. Они будут посвящены проблемам социальной и экономической привлекательности научной деятельности и вопросам вовлечения молодежи в науку.

С 2001 года Центр проводит международные научные форумы при поддержке ЮНЕСКО и Международной ассоциации академий наук (МААН), в работе которых принимают участие ученые Украины, СНГ и стран дальнего зарубежья. В октябре 2011 года состоялся Международный симпозиум *«Перемещение центров научно-технологической активности на европейском пространстве и мобильность ученых и специалистов между странами: современные тенденции»* (сайт Симпозиума — http://www.stepsmoving.ho.ua).

Центр является соорганизатором ежегодных Международных конференций по инновационной политике, проводимых в г. Алушта (Крым), а также организует или является соорганизатором непериодических конференций, посвященных актуальным проблемам науки и науковедения. В частности, в 2010 году была проведена международная конференция «*Актуальные вопросы охраны прав интеллектуальной собственности в Украине и Европейском Союзе в контексте европейской интеграции*».

Организацией и проведением международных форумов международное сотрудничество Центра не ограничивается. Исследователи ЦИПИН им. Г. М. Доброва НАН Украины выполняют совместные проекты с научными учреждениями стран Европейского Союза, СНГ, Китая и других государств и международных организаций. Ряд сотрудников Центра являются экспертами международных программ, членами *Европейской ассоциации исследований и технологий*, *Европейской ассоциации по эволюционной экономике*, *Международного союза по наукометрии и информетрии*, *Европейской международной исследовательской и образовательной программы* и других организаций, членами редколлегий международных научных журналов: *«Образование и наука»*, *«Технологическое обучение, инновации и развитие»* (*“International Journal of Technological Learning*, *Innovation and Development*”), *«Инновации в цифровой экономике» (“International Journal of Innovation in the Digital Economy”)* и др.

Центр является базовым учреждением Национального контактного пункта (НКП) Седьмой рамочной программы (РП7) Европейского Союза по исследованиям и технологическому развитию по приоритетному тематическому направлению «Социально-экономические и гуманитарные науки», созданного на основании совместного приказа Государственного агентства по вопросам науки, инноваций и информатизации Украины и НАН Украины от 16.02.2011. Основные направления деятельности НКП: предоставление информации о конкурсах и мероприятиях РП7, организация практических семинаров и тренингов по составлению проектных предложений, помощь в поиске партнеров и координаторов, индивидуальные консультации по вопросам участия в конкурсах и мероприятиях РП7. Руководитель НКП — кандидат экономических наук, старший научный сотрудник Центра О. В. Кот. Сайт НКП — www.stepsfp7.ho.ua.

Центр ведет активную издательскую деятельность. Кроме международного журнала «*Наука и науковедение*» совместно с *Киевским государственным центром научно-технической и экономической информации Министерства образования и науки Украины* с 1998 года издает межотраслевой научно-практический журнал «*Проблемы науки*». В соответствии с *Постановлением Президиума АН УССР от 22.07.1986* Центр продолжил выпуск периодического научного сборника «*Очерки по истории естествознания и техники*», ранее издававшегося Институтом истории АН УССР.

Некоторые монографические публикации, которые достаточно полно иллюстрируют область исследований Центра, приведены в списке литературы.

Постоянно обновляющаяся информация о деятельности Центра исследований научно-технического потенциала и истории науки им. Г. М. Доброва НАН Украины, в том числе детальные сведения о его научных отделах и ряд публикаций Центра в электронном формате (выпуски журналов, монографии, сборники, отдельные статьи), а также другие науковедческие и историко-научные труды (включая наибольшее в настоящее время электронное собрание произведений В. И. Вернадского — одного из провозвестников науковедения) есть на сайте Центра http://stepscenter.at.ua.



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## Center of Science Studies in Ukraine

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In 2011 was marked 25 years since foundation in 1986 G. M. Dobrov Center for Scientific and Technological Potential and Science History Studies (G. M. Dobrov STEPS Center) of the National Academy of Sciences of Ukraine (1986) and 20 years from the getting of the status of independent academic institute (1991). This article is devoted to the formation and modern situation of the G. M. Dobrov STEPS Center with whom development of Science of Science in Ukraine is indissolubly linked.

***Keywords:*** Science, History of Science, Center for Science and Technology building and the history of science (TSIPIN) them. G. M. Dobrov

# SCIENCE AND TECHNOLOGY DEVELOPMENT IN THE INDIA

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## Science, Technology & Social Stratification in India: A Critical Perspective

One of the most profound sociological problems that S&T in India face today is that of the role of S&T in relation to social inequalities. The paper analyzes (at macro level) the role of S&T particularly in relation to the system of social stratification and other forms of social inequalities both within and outside the system of S&T in India. As a socio-historical analysis based on secondary data and findings the paper articulates a few original formulations on the role of S&T in (post independent) India in the contexts of major trend developments (in different decades) like: (i) Modernization of S&T, (ii) Green Revolution induced by technology intensive agriculture, (iii) Development as triage benefiting, selective sections of the society, and (iv) the ICT revolution in India during the last two decades. This is essentially a critical non-western view, i. e. a view of the periphery from the periphery itself.

***Keywords:*** S&T induced inequalities, Class formation, Modernization of S&T, Artificial elitism, Emergence of big S&T, Development as triage, Green revolution, ICT revolution, Cyber coolie, Techno coolie.

Science and Technology together have come to be known as the most dominant tradition of mankind today. It is difficult to imagine a discussion on the development of the modern world or on the potentialities of human life in the future which does not almost immediately focus on the role of science and technology (S&T) in the development process. Nor is an analysis of the problems we face at present likely to mean much, if it does not involve some attempt to understand the complex interaction of S&T with society. At many different levels S&T are intimately bound up with our hopes and our fears, as well as our quality of life. They have given us standards of comfort and technical marvels unthought of earlier, and they promise more; but they pose threats too, graver in many ways than those posed



in the past. Operating in the socio-economic order of unequals S&T have favoured the life chances of some and have dammed those of many. Hence in this paper I am attempting to articulate the very many complex ways in which S&T have marred the livings of the teeming millions of a developing country. It is only part of the truth, I intend to discuss, as S&T have enhanced the life chances of many although with varying degrees.

At the out set it almost becomes necessary for me to explicate my value premise that modern S&T are essentially value free enterprises (methodologically). Epistemologically it is modern science that originated in the west/Europe and through application gave rise to modern technologies (scienticized). These acquired universal character under the European rule of the world in the 18th and 19th Centuries. These have been the companion of European powers for expansion of colonialism and even the instrument of domination of the world in the post world war times. These have been claimed to be universal and value free as these have been the means of domination and means of legitimization of regimes both in democratic as well as socialistic worlds (in spite of the democratic ethos of modern science for which it has been said to be the companion of democratic polities, Merton, 1973: 254–266). Further modern science is said to be value free/neutral because of its applicability irrespective of the context like nationalism, ethnicity, religiosity, etc. Lastly, it has been claimed to be universal and value free as this could be used in all the societies of East and West or North and South (irrespective of its societal history). Modern S&T operate in a given political-economic frame work which usually has its ideological hues. As a subsystem S&T acquire the hues of its political-economic frame work in which it operates. Therefore, given the structure of inequality in a particular society S&T yield the result accordingly and benefit the people of various strata proportionately. Thus S&T today are mere instruments of development that help perpetuate the system (of stratification) unless used to challenge the latter (as in history this modern science also has been the means of enlightenment and liberation of the masses from colonialism and feudalism).

Therefore, I argue here to show how S&T have determined the social stratification within the Indian S&T in particular and Indian society in general, in the context of four major trend developments (in post-independent India) such as: (A) Modernization of S&T in India (B) Green Revolution induced technology intensive agriculture, (C) Development as triage causing massive displacement and loss of livelihoods, and (D) Information and communication technology (ICT) revolution. Although the four trend developments are post-independent phenomena but have their own time frames. Of the four, the first two trend developments although were parallel but being contemporary overlapped each other's time of reference (i. e. 1960s). Similarly the latter two trend developments although have been parallel (mid-1980s onward) but have overlapped each other's time of reference (i. e. 1990s) significantly. Although based on secondary data and findings these formulations and the arguments therein are the original formulations of the paper. Hence this analysis essentially is from the vantage of a non-western perspective, i. e. a view of the periphery from the periphery itself.

### (A) Modernization of S and T in India (during 1950s–1970s):

In the non-western traditional societies, the fundamental and core values maintain certain autonomy in relation to the values of modern S&T that are usually instrumental in character. Hence it is very likely that when modern science and certain systems of technology acquire

universality their adaptation or 'mix' with the fundamental or core values of a traditional society would differ and result in the emergence of a 'culturally relative system' of S&T. But this merely is a logical possibility.

Modern S&T entered into India and similar non-western traditional societies in the company of imperialists. By that time S&T had already acquired the support of state power in Europe as these were conceived to be the principal instruments of the development for European societies and instrument of exploitation of the colonial societies. Hence, from the beginning, S&T as major instruments have been responsible for the development of the western societies and for the underdevelopment of the colonial societies. The colonial regimes on the one hand imposed modern S&T in the traditional societies and on the other eliminated the indigenous forms of S&T in these societies. In this process of imposition and elimination during the long colonial period the colonizers found the native bourgeoisie as its closest ally to implant and lead the western development model.

Of late when colonial societies acquired political freedom, their ruling classes continued to look at the West, their erstwhile rulers, for all round development, what we all know as 'westernization'. The western scientific education in these societies justified the western mode of development for these traditional societies. Having eliminated the competing forms of native S&T in traditional societies, modern S&T had acquired a universal character and had left no alternatives in terms of knowledge and thereby no other development models for the traditional societies except that of the West. Unfortunately the indigenous intelligentsia of the traditional societies was itself an offshoot of modern western S&T education, whose role was then indeed to formulate it's 'culturally relative system' of S&T and a corresponding mode of development for India.

S&T and development have always been inextricably linked. Like the concept of development, S&T have come to be treated as universal and evolutionary. But the conception of universal and evolutionary S&T is based on two fallacious assumptions, such as (1) societies could be arranged into a system of hierarchy in which the core values would be essentially derived from the dominant value orientations of technologically advanced societies. Here the cultural superiority is combined with political superiority. (2) S&T in traditional societies is identified primarily through their abstract principles, calculi of abstractions, and models and not with their concrete manifestations of realities. As a result, development of S&T in the traditional societies was compared with that of developed societies where the indicators were different and too lofty to be achieved. Thus it is a fallacy grounded on wrong models of comparison. Of the two assumptions, if the first one is based on the 'culturological fallacy', the second one is based on 'fallacy of over-abstraction' (Singh, 1977: 137). Therefore, S&T in the then traditional societies and in today's developing societies have not been able to contribute significantly, neither for the upliftment of the poor masses nor towards development of the S&T itself.

The structural form of present day scientific and technological revolution in the developing societies is characterized by two important features such as, *contemporaneity* and *contradiction*, says Yogendra Singh (1977: 141). Contemporaneity is more a cultural reality which refers to a new value orientation that corresponds to attitudinal modernity (present orientation dominates over past, belief in the possibility of transforming life chances over fatalism, etc). Whereas contradictions are the structural ones engendered by the S&T modernization in India.



***(i) Artificial Elitism in science*:** The structural contradiction of the scientific and technological revolution lies in the linking of S&T in developing societies to that in the highly developed ones. This contradiction in fact refers to the biggest form of inequality as S&T in developing countries remained to be dependent. Owing to the historical dependence of scientists and scientific institutions on their counterparts in the developed nations right from the colonial period the roles of scientists and scientific institutions in developing societies in improving the life chances of their people tend to be marginalized. Their goals and aspirations are alienated from the fundamental needs of production and innovation in their own societies. Their underdevelopment as well as their artificial linkage to the scientific institutions and scientific communities of the developed countries thwarted their capacity to invest in their indigenous R&D activities. These scientists being placed in the developing societies tend to do research in the areas of S&T that are of interest to the developed societies. The compelling reason to do so is to win grants/awards/prizes and recognitions from the developed countries that have attached rewards to those frontier areas of S&T that are relevant to them only.

This also resulted in artificial elitism among scientists in developing societies. Thus, far from playing a meaningful role in improving the life chances of the teeming millions of their societies, S&T in newly developing countries have alienated themselves from the needs of the masses. {However, S&T in India have been some what different in this regard, particularly in selected areas like, transportation, telecommunication, information technology and the like that have reached out to the poor too.} At the time of independence India's capacity for higher education was small and was catering to the needs of the middle and the upper middle classes only. Hence in a sense it was elitist. But with the growing democratic decentralization and socialist impetus of the policy, higher education became mass-based, of course at the expense of serious quality measures. This gave rise to proliferation of universities and institutes of higher education in India. The class of Indian scientists, which manned these universities/institutes of higher education, had its origin in colonial India, proliferated in post-colonial India as the higher education did. In the year 2006, there were 354 universities (including 62 deemed universities). Of these 172 were conventional and universities (including 33 institutions for specialized studies in disciplines), 37 institutions provided education in agriculture (including forestry, diary, fisheries and veterinary science), 16 in health sciences, 38 in engineering and technology, 6 in law and journalism and 10 are open universities (AIU, 2006: XI). The scientists working in these universities/institutes make the academic scientific community of India.

***(ii) Emergence of Big S&T:*** Further, a structural aspect of the scientific and technological revolution in India refers to the emergence of 'Big S&T' in Nehruvian Era of post independent phase. The roots of Big S&T in India could be traced back to the Nehruvian regime and belief of Nehru in then Soviet Socialism. Being impressed by the performance of the then soviet model Nehru had adopted for India several features of Soviet model of economic development like, centralized 5yr plans, infrastructure building by the state, promotion of state capitalism through creation of large PSUs, Policy of self-reliance and import substitution in S&T etc. Emerged from these the Big S&T in India and flourished under the socialistic thrust of subsequent regime in the 1970s. A few broad features of Big S&T in India could be articulated as follows:

(i) Big budgetary provisions (mostly through Five year plans / master plans) and massive expenditures met by the federal government (including non-plan expenditures): A cursory look at the India's federal expenditures on S&T (DST data base) from the 1550s to mid 1970s reveals the preponderance of a few large S&T agencies in budget allocations, like

those of, Dept. of Atomic Energy (AEC), Defence Research and Development Organizations (DRDO), Council of Scientific and Industrial Research (CSIR), Indian Council of Agricultural Research (ICAR), Department of Space (ISRO).

(ii) Organizing S&T by founding big S&T organizations with large manpower and bureaucratic structures: e. g. ICAR, DAE/AEC, DOS/ISRO, DRDO, CSIR, ICMR etc. These are centrally funded and regulated S&T organizations and their agenda were politically determined.

(iii) S&T development through central plans of action: e. g. *Atom for peace*, *Green Revolution*, *Satellite programmes for education*, *Operation Flood* (revolution in milk production), Flood control measures (through Flood Commission of India), etc. Similarly the other feature was building big scientific and technological projects like, several large multi purpose river valley projects, e. g. DVC, Hirakud, Bhakra Nangal, Nagarjun Sagar, etc and large technological and industrial enterprises like, SAIL (consisting of five large Steel plants like those at, Durgapur, Bhilai, Rourkela, Bokaro and Burnpur), ONGC, HAL, NTPC, RCF, BHEL, BEL etc.

(iv) Big S&T were essentially dependent upon the state support: These could not grow without the state support (through funding) and protection (through policy measures). These grew under the protection umbrella of the state without competition both from within and outside the country.

(v) Being fully funded by the federal government, these Big S&T organizations were not open to evaluations from outside for their performances. These had set their own standards to evaluate themselves and the methods of evaluations were also devised by themselves. These could be possible alone under the then closed door political economy.

This may give rise to an epistemological question that probably unless organized in a very big scale the modern S&T could not have become cost effective and also could not have delivered the services/goods it was supposed to. And the other relevant question that emerges from the above articulations is that probably Big S&T is a feature of Socialism as Big science grew in the then USSR also and India had acquired some of the features of the then USSR. However the best example of big science was the then Soviet science and in today's context it is that of the Russian Academy of Sciences where fundamental research is carried out. In the context of Soviet science big science precisely meant a vast percentage of the budget used to be devoted to designing experiments and making experimentations. By nature it used to be fundamental, non-innovative and non-market oriented. This big science had been known for discoveries and theory building than for innovations and commercialization. The big science of USSR/ Russia is also over organized meaning very large in size and bureaucratic in structure. But my notion of Big S&T of India is fundamentally different from that of the USSR/Russia as these were never meant for fundamental research, rather were for innovations and commercialization or for attaining popular needs directly. Although created to do so but the big S&T in India under government funding and protection never became market oriented during the initial three decades (i. e. 1950s to 1970s).

However, in this context, the implications of the rise of big S&T in India was the loss of significance for academic S&T research. Because with the shifting attention and funds of the state to big S&T the academic S&T mostly based in the universities / academic institutes became redundant for national developmental purposes. Although Big S&T remained vastly unaccountable (e. g. the Light Combat Aircraft project of the HAL) but overshadowed the academic S&T research. Being kept away from the national purposes (developmental/ industrial) academic S&T research in India remained poorly funded and confined to their



academic interests only. Having survived as the poor cousin of Big S&T, academic S&T research in India of late has started interacting with industry for problem shooting and adaptive purposes only.

The logical corollary of the emergence of Big S&T and artificial elitism in science was the emergence of several Peoples' Science Movements (PSM) in India that aimed at taking science to people and forging the link between people and S&T directly. As an alternative to elite science, a group of enlightened and reformist (non-radical) scientists and engineers in Maharastra, in order to take science to people for enlightenment had launched a PSM organizations called *Marathi Vidnyan Parishad* way back in early 1960s. Even today *Marathi Vidnyan Parishad* pursues its goals in more organized manner even beyond Maharastra but among the *Marathi* speaking people. On the contrary, also in the early 1960s, with a view to demystifying science and linking people with S&T at grassroots level, there emerged a radical PSM in the southern state of Kerala spearheaded by the *Kerala Sashtra Sahitya Parishad* (KSSP). The PSM of KSSP was on its peak during the 1980s to 1990s and now in decline. Similarly, as the alternative to elite science, emerged the radical Science Teaching Programme of Hosangabad fame (HSTP) in the early 1970s by two voluntary organizations named *Kishore Bharati* and Friends Rural Centre. This programme was subsequently carried forward by *Eklavya* a radical PSM organization in Madhya Pradesh. And for an alternative to the Big S&T in India there emerged again a radical discursive movement of Appropriate Technology (based on E. F. Schumacher's *Small is Beautiful* thesis and Gandhian vision of small/alternate technologies like *Charkha*) resulting in the establishment of research centres like ASTRA at IISc Bangalore, CTARA at IIT Bombay, etc. Similarly another group of radical scientists and engineers consolidated their thinking and brought into existence the Peoples' Patriotic Science and Technology (PPST) Foundation at Madras and published a radical magazine named 'PPST Bulletin' to advocate for people centered/ ethno and indigenous S&T (local craft based technologies that once flourished in the history). This micro-movement virtually lasted for nearly two decades. In continuation with the radical thinking in S&T came into existence another PSM organization at Delhi known as the Delhi Science Forum (1978) which was again discursive in its activities, i. e. mainly to develop a viable criticism of S&T policy in India. Finally then emerged a more comprehensive all India PSM organization named the *Bharat Gyan Vigyan Samiti* (BGVS) in the late 1980s out of the *Bharat Jan Vigyan Jatha*. Although its leadership was rooted in KSSP and its radicalism, later was allured by the central government to lead its mass literacy mission. The BGVS leadership although maintains its popular-base and mobilization activities particularly for spreading literacy, has already lost its radical punch. Now it is a semi-government organization engaged in literacy and science popularization activities.

Lastly, another note worthy and natural corollary of the emergence of big S&T and elitism in S&T research in India was the emergence of an anti-science and anti-technology movement in India which was again discursive by nature. This movement involved only a handful of scholars and was a short lived one. The beginning of the anti-science movement in India could be traced back to the early 1980s. Because *'A Statement on Scientific Temper'* collectively issued by a good number of ruling scientists and intellectuals of the country lead by P. N. Haksar in the year 1981 provoked so much of criticisms and reactions for years that it became the most hotly pursued debate in independent India's public sphere. The scathing criticism of the statement came from Ashis Nandy (1981) as a 'Counter statement....' portraying the first statement as scientism devoid of humanism. Carrying forward the criticism of modern S&T thereafter came some books from Ashis Nandy (1988), Vandana Shiva (1988, 1991) Claude

Alvares (1994), and a few others that were essentially anti-science and anti-tech writings. Because along with the authors of his edited book, Nandy (1988) not only emphasized the violent and hegemonic nature of modern S&T but also argued for a pluralistic version of science making legitimate claims for alternative sciences (ethno) and small/appropriate technologies. And subsequently Shiva (1988 and 1991) and Alvares (1994) attacked the anti-developmental thrust and anti-ecological foundation of modern S&T to portray it as a patriarchal/male enterprise. However this fervor did not last long and died down by the mid 1990s.

***(iii) The stratification within Academic S&T:*** But this vast body of Indian academic scientific community is not undifferentiated and not a homogenous one. As the reflection of the larger social order this community is also a stratified one. The stratification among the scientists exists in term of their research output and subsequent recognition that further earns them huge grants, students, infrastructure, etc, to strengthen their professional standing. Following the notable study of Diana Crane (1965: 699–714) among American scientists where she pointed out the existence of a system of stratification in terms of their productivity and recognition (i. e. major and minor university departments), Cole and Cole (1967: 377–390), Gaston (1970: 718–732), Cole (1979: 353–394), etc did acquire similar results in their respective samples. Pattnaik in his study among Indian academic scientists (2001: 62–95; 2003: 189–220) has also found the prevalence of a system of stratification in terms of productivity and recognition. His study not only verified the prevalence of "Mathew Effect" and the 'accumulative advantage hypothesis' in the Indian sample but also pointed out the prevalent 'Elitism in Indian Scientific Community'. His categorization of university departments into major and minor (like that of Diana Crane) was highly justified. Further, Pattnaik's findings (2001: 61–93) on highly skewed research output in terms of quality and creativity makes the prevalence of stratification among Indian academic scientists more obvious a phenomenon.

Based on the sampling and empirical findings of Pattnaik's study (2001 and 2003) the Indian academic scientists in major departments could be identified as those in elite national scientific and technological institutions like Tata Institute of Fundamental Research (TIFR), Indian Institute of Science Bangalore (IISc.), All India Institute of Medical Sciences (AIIMS), Post-Graduate Institutes in Medical Research (PGIs), Indian Institutes of Technology (IITs), Indian Statistical Institutes (ISIs), Harischandra Research Institute (HRI), Bose Institute of Physics, etc. These scientists in major departments are highly productive both in terms of quantity and quality research output and receive much more awards/honours and recognitions compared to their cousins in the poor state universities. Because one hardly requires any official data source backing to observe that the most prestigious scientific and technological research awards of India like the Swarn Jayanti Award, Shanti Swarup Bhatnagar Award, INSA Award, the Young Scientist Award, etc. are mostly cornered by scientists of these national institutes. The class differences in output maintained by the major departments are indicative of their similar class differences maintained in terms of their input variables like infrastructure, research environment, prestige of the graduate school (Alma Mater) of the scientist, motivation level among scientists, reward system in the organization, etc. against the minor departments in the universities.

***(iv) Import substituted Industrialization and technological dependence:*** To explicate further the contradictions of the modernization of S&T, it may be worth noting that the rich world of the north has only a quarter of the world population, but it has not only nearly 90 per cent



of the world's scientists but also 90 per cent of the world's MNCs and it spends 95 per cent of the total funds devoted to R&D. It dominates trade and patent systems and hence technology of the world. Therefore, the contradiction also implies that the overwhelming proportions of industrial technologies in developing countries are imported from the developed countries. Such technologies in the beginning of the import regime did not help in producing commodities for the requirements of the masses and those of particular qualities which might improve the living standards of the masses. Imported technologies in most developing countries of South Asia, Africa, Latin and South America (otherwise known as the South) have been successfully used for the production of 'high quality' goods' to meet the needs of high income groups and the middle class. This contradiction basically emanated from the social structure of these countries. For, most of these countries were at some point of time colonies of one or the other developed countries of today. As the colonial situation led to the formation of the upper and middle classes in these countries, these classes continued to find their cultural role models in the western living style and mode of consumption. The preponderance of middle and upper class interests in the bureaucratic and policy-making bodies of developing countries has distorted the industrial and S&T policy in its favour to sustain their consumption pattern which is essentially western and thus developed. Hence, imported technology in developing countries met if not those of the masses, but the needs of the upper and middle classes and added to their better quality of living. Hence the policy of Import Substituted Industrialization (ISI) was pursued. This of course remained to be the trend till the 1970s. The policies of self-reliance and import substitutions remained in the peak during the 1960s and 1970s. India's policy of self-reliance in 1960s was the reflection of the nationalistic fervor / Swadeshi movement and later the socialistic inclinations of Indian political economy. The policy of ISI was partly caused by the above stated structural requirements of Indian society and partly caused by the adaptive lessons learnt from the then Latin American economic crisis.

However, the problem did not end here, with these disparities between classes. As part of the ongoing process, import of technologies to the developing world from the developed ones engenders a set of other but related problems of a serious nature for the developing countries, such as: capital crisis/balance of payment crisis on account of monopoly pricing of technology and raw materials, transfer of inappropriate technology in term of capital and labour intensity, transfer of obsolete technology which may not be economically viable and mostly environmentally hazardous, energy crisis and distortion of the priorities in production and investments in developing countries.

India in early 1950s had started industrializing with the policy of open door economy and MNC led industrialization but by mid-1960s India had switched over to closed door policy with MRTP and other restrictions with import substituted industrialization. Under world capitalism where the developed and developing countries are related in terms of centre and periphery, technology had not only become a mode of domination but also means of exploitation. Because technology transfer from developed to the developing countries took place within a political structure of dominance and compliance.

Indian industries like those in other the then third world countries were fleeced by the MNCs of the West, as huge volume of money flew back to their parent companies, because of: (1) high lump sum license fees, (2) high rate of royalty, (3) repetitive collaborations, (4) high spare parts cost, training and consultancy fees and (5) several prohibitive clauses imposed by the MNCs in the agreements. Very little or virtually no export of industrial products (mostly because of denial of export rights) did not allow Indian firms any industrial in-

novation and compensatory income in foreign currencies. In-house R&D existed for name sake in large industries but was vastly adaptative by nature and not innovative. Thus the net result of Indian industrialization then (till 1980s) was technological dependence (Stewart, 1977). But it is noteworthy that this dependent industrialization in the beginning had given rise to the new class of skilled industrial workers and the new class of industrial professionals/ managers for the first time in post independent India.

Much has been written about the problems associated with the transfer of technology to Indian firms from foreign ones and the inbuilt problems of in-house R&D. Noteworthy among those were by: M. Bell and Scott Kemmis (1985), Subramanium K. K. (1972), Balasubramanian (1973), Parthasarathy A. (1977 and 1979) Desai A. V. (1982, 1988) Katrak Homi (1985, 1989), Kumar Nagesh (1994), Pattnaik (1999) and Kher M. (2001). To counter the misgivings of this process for industrial development the panacea was to come from the policy of import-substitution. Indian in-house R&D took off as a reflection of this policy and consequently developed a pattern of being only highly adaptative and not innovative. Whatever be it, in-house R&D in Indian industry was mostly confined to large firms. Several studies have pointed out this phenomenon of Indian industry that there existed a positive correlation between 'firm-size' and 'R&D intensity', e. g. Sherer, (1980 and 1984), Sanjay Lall (1980), Siddhartha (1987), A. V. Desai (1980), Homi Katrak (1984), Mohan Pillai (1979), etc. Thus in terms of in-house R&D output, may it be adaptational or low-end technical innovation, it is the R&D scientists of large firms which stood a class apart compared to those in the other. Conspicuous among the large Indian firms were the in-house R&D of large PSUs like BHEL, BEL, ITI Ltd., HMT Ltd. and now in the post liberalized economy in-house R&D of the large private sector firms like, L&T Ltd, Titan Industries Ltd, TELCO, Reliance Industries Ltd, Dr Reddy's Lab, etc have been distinctly innovative (Bownder and Richardson, 2000). And still conspicuous in-house R&D were those of certain identified industrial sectors like, Drugs and pharmaceutical, Chemicals, Automobiles & Electronics. But the most conspicuous in this sense have been the Indian software sector during the last two decades.

Owing to the policy of self-reliance and import-substitution, industrialization in India during the Nehruvian regime had tried to counter the process of technological dependence and established a chain of more than 40 industrial research laboratories under the CSIR. But these laboratories in those years functioned more like government departments without any accountability and promises to deliver. These had virtually no productive research output to benefit the people. The commercialization rate of their technology was very low and in the subsequent stage, their rate of failure was also very high. And they continued to be fully government funded.

As part of the same process of modernization of S&T, this was also the time when in support of the policy of self-reliance and import-substitution India created several scientific departments like Department of Science and Technology (DST), Department of Atomic Energy (DAE), Department of Telecommunications (DOT), Department of Electronics (DOE), Department of Oceanography (DOO), Defense Research and Development Organization (DRDO) etc. under the central government and good number of large semi-autonomous R&D bodies like the Bhabha Atomic Research Centre (BARC), Atomic Energy Commission (AEC), Indian Space research Organization (ISRO), Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR), etc with central funding. The departments manned by highly qualified technical manpower only regulated government policies and funding. On the contrary, the latter as R&D organizations were



engaged in more of developmental works and less of research works. As these are all government funded bureaucratic organizations and bulk of their works are developmental and often strategic by nature, no study has yet successfully been conducted to point out any form of elitism/stratification that existed among their scientists.

Thus the process of modernization of S&T in India created a new sub-class, i. e. part of the great Indian middle class intelligentsia: the Indian scientific community consisting of (1) Academic scientists of universities/academic institutes, (2) Scientists in the Government departments/semi-autonomous S&T agencies and the CSIR labs, and (3) Industrial scientists and engineers in the R&D units (both in public and private sectors).

## (B) Green Revolution induced by technology intensive agriculture (During 1960–1970s):

In this context I am to show how the Green Revolution (GR) was necessarily paradoxical. On one hand it offered technology as a substitute to both nature and politics, in the creation of abundance and peace. On the other hand, the modern technology itself (being resource intensive) demanded more intensive natural resource use along with intensive external inputs and involved a restructuring of the way power was distributed in society. While treating nature (organic farming) and politics (agrarian politics) as dispensable elements in agricultural transformation the GR created major changes in ecosystems and agrarian social structures. GR supposed not only new relationships between science and agriculture, but also introduced new links between the state and the cultivators, between international interests and local communities within the framework of the agrarian society.

While peasant movements in the then third world societies tried to restructure agrarian relationships through recovery of land rights, the GR tried to restructure social relationships by separating issues of agricultural productivity from issues of justice. GR technology comes to the 3rd world essentially to depoliticize the agrarian societies from Left-wing agrarian politics. As it was in Latin America, (e. g. Mexico) so was it in the East and the South East Asia. When the Chinese Communist Party came to power it encouraged peasants' associations to seize land, cancel debts and redistribute wealth. Peasant unrests in other Asian countries like India, Philippines, Indonesia, Vietnam, Malaysia, etc. flared up. The new political authorities in these Asian countries had to find means to control the agrarian unrest and stabilize rural political situations.

The Capitalism responded immediately. In order to arrest the expansion of Red Chinese influence and to defuse the communist appeal the new Asian Governments were invited to join the British American sponsored Colombo Plan in 1952. It explicitly set out to improve conditions of rural Asia by defusing growing left wing agrarian politics. Rural development associated by foreign capital was accepted by these countries to stabilize their country-sides. So American agencies like Rockefeller Foundation, Ford Foundation, US aid, the World Bank, etc. mobilized themselves for a new era of political intervention in the then third world countries. Hence while GR was clearly political in recognizing agricultural systems, the concern for political issues such as participation and equity were consciously by passed and were replaced by the political concern for stability. It was projected that the miracle seeds of GR were the seeds of plenty, will create material abundance and reduce agrarian conflicts in rural India.

Having said about the politics of GR, now we have to bring out the stark realities of GR what it gave rise to. As I noted in the beginning of this section, GR has been a paradoxical phenomenon. Although it aimed at depoliticizing the agrarian societies by reducing the agrarian conflicts of particular type in the long run it has given rise to new type of politics and conflicts e. g. the thirsty seeds of GR created demand for intensive irrigation. And the intensive irrigation of GR Technology consumed huge quantities of water for irrigation. This irrigation has consumed both surface water as well as ground water. As a result it created problems of water logging and salinity. Scarcity of canal water for irrigation has also created regional political tension, e. g. among states of Punjab, Haryana, and Rajasthan, among the states of Karnataka, Andhra Pradesh and Tamilnadu. This also encouraged creation of centralized use of water as well as power and there-by demand for the creation of large Dams. With increasing demand for water, as Dams grew old, the decreasing storage capacity caused intensive conflict for water.

To be more explicit about the kind of social inequality that the GR technology produced in India, one has to start looking at the social consequences of the 1950s India's Community Development Programme (CDP). The CDP was launched in India with the active financial, administrative and technical guidance of the Ford Foundation and the Technical Cooperation Mission of the US government. The CDP ran for more than a decade but failed to make any impact on production. As pointed out by A. R. Desai (1969: 611–622) and the Government of India's, own Programme Evaluation Organization Report (GOI 1957) unequivocally stated that whatever benefits accrued by the CDP, went to the rural elites to the exclusion of the lower-caste cultivators, landless and the backward castes. In addition it was found that the CDP gave an opportunity for the land owning elite to further strengthen its positions of authority as the programme was administered through them and expected to percolate to the masses.

In the second phase of this American aid programme, came the real technical inputs from the USA. The foundation of research in agricultural sciences in India was led in the pattern of Land Grant Institutions of USA. The total agriculture aid to India involved Ford and the Rockefeller Foundations and the US Agency for Industrial Development (USAID). The aid package was directed towards: (1) Establishment of agricultural universities in India, (2) Crop improvement through "miracle seeds", (3) Supply of Fertilizers and Pesticides, (4) Provisions for American technical expertise, (5) Training of Indians in American agricultural universities, and (6) Soil testing and other related programmes out of the PL.480 funds (Naik and Sankaram, 1972). In the early 1960 came the Integrated Agricultural Development Programme with heavy capital intensive and mechanized agriculture particularly in the areas of assured irrigation. By end of 1960s the productivity level had gone up dramatically. The Bumper crop of 1970–1972 was attributed to the blessings of the weather gods and not the 'miracle seeds'. The Green Revolution had arrived; India attained self sufficiency in food production. But finally the role of HYVs/miracle seeds was recognized in the context of wheat growing regions only.

A mid term review of the net outcomes of and impact of GR on Indian country side was attempted by Centre for the Study of Social Change 1974, and it was asserted that the GR technology had a rich peasant bias and hence had disproportionately benefited the rich peasantry. The second review was attempted in 1973 by the London based Halslemer Declaration Group (HDG) and it also assailed the rich peasant bias of the GR technology because the government facilitated institutionalized subsidies like, cheap irrigation, cheap credit and other facilities that were relatively more accessible to the big farmers.



Although based on the study of Bhalla and Chadha (1983), D. N. Dhanagare (2001, 330–352) tried to point out that the small and marginal farmers in Punjab did not lack motivation, dynamism, initiatives and entrepreneurial abilities by showing an equal rate of productivity to that of rich peasants then. He concluded that, these abilities neither did help them substantially nor did it reduce the growing inequalities.

Even in a micro level-longitudinal study of two villages from Mandya district of Karnataka (1955 and 1970) Scarlet Epstein (1978) has pointed out the growing agrarian disparities, as the upper caste based big farmers (Lingayats) were the largest beneficiaries of the GR technology and infrastructure. Epstein categorically pointed out how the rural cooperatives then were serving the wealthy farmers. Thus, as it looked then, the GR technology worked in a socio-economic framework which was already unequal or highly stratified. The GR technology introduced then could not benefit all sections of the rural society equally. Lastly a more decisive study came from Dandekar and Rath (1971: 70) concluding that the process of rural development during the decade of 1960s has benefited the upper-middle and the richest section than the lower-middle and the poorest sections of rural India. The broader constraints that came on the way of an equalitarian growth in rural India were the following:

1. Capital intensive character of the GR technology: The GR technology was not scale-neutral in terms of productivity. Hence its capital intensive nature made it favourable to that section of the peasantry which could afford and mobilize the resources.

2. A study conducted by the Reserve Bank of India in 1967–1968 among small farmers pointed out that institutional credit facilities were not adequately available to them as they were available to big farmers. Even the credit cooperatives were cornered by the big farmers. And the small farmers relied mostly on private money lenders who on the contrary were notorious for fleecing the small farmers.

3. The other major constrain which went against the interest of the small tenant farmers was the prevailing land tenurial system. Even the 4$^{th}$ five year plan document of Planning Commission of India noted the same that the insecurity of informal tenants and the prevalent share cropping practices not merely impeded the widespread adoption of GR technology but in some cases also led to social and agrarian tensions.

4. The other important constraint was the GOI's policy for food grain prices. This also went in favour of the big farmers. The Agricultural Prices Commission of India (1968: 10; 1972: 3) also have noted this. Since the new technology was expensive, the price offered by the government to buy wheats and cereals had to be high enough to make the adoption of the new technology profitable. So the high procurement prices of the government also benefited the big farmers.

5. An additional constraint in the way of the small and marginal farmers' acceptance of the new technology had been the eating habits of the rural masses of India. The eating habits favoured the traditional varieties and often for domestic consumption small and marginal farmer preferred to cultivate the traditional varieties in a traditional pattern of cultivation.

Even in a more recent study reported by Mohanty (1999: 56) based on the Satara district of Maharashtra, pointed out that owing to the growing capitalist agricultural practices in agriculture (sugarcane cultivation) there has been a steady decline of cultivators and steady rise of agricultural labourer in the district between 1961–1991. This is a strong indication of depeasantization caused by modernization of agriculture. The paper also pointed out that the modernization of agriculture here has immensely benefited the big farmers (1999: 59).

With the emergence of capitalist farmers and capital intensive agriculture there came into existence mechanization of farming. The modernization of farm technology might have

been beneficial to the rich peasantry but it becoming highly injurious for the agricultural workers of India. The effects of mechanization as reported by Dhanagare (2001: 341) were visible in the form of 5000 deaths in India resulting from machinery accidents by 1978. In early 1980s it was reported that every year more than 300 farm workers used to be incapacitated during wheat harvesting in Punjab alone. There were large number cases of loss of limb reported among farm workers during the harvesting season in north Indian states. Agricultural works in these areas have been rendered even more injurious by increasing use of poisonous sprays/pesticides for plant protection. Poisoning out of pesticide sprays is not confined to India alone; rather it is a noticeable phenomenon for all the Asian/Latin American countries who adopted the GR technology. Victims of such poisoning were invariably the agricultural labourers. But there seems to be an absence of any legal protection or compensation provision for farm labourers in case of such health hazards and accidents.

Added to these were the observations of Oommen (1975: 175) that owing to the growing penetration by capitalist agriculture into countryside, the process of depeasantization has been accelerated and consequently large numbers of small and marginal farmers or poor peasants have been pushed to the ranks of landless labourers. Further as reported by Bhalla (1976) when capitalist farming came into existence the average demand for labour dropped down to 25.6 mandays. In certain prosperous parts of Haryana, the GR resulted in the replacement of traditional paternalistic relationship between big farmers and their workers by formal contracts. But in most other parts of country the household attached labourers were simply thrown out of work or being converted into casual labourers noted Gough (1977). Further because of mechanization of agriculture the vast migrating labour force from Bihar, UP, Bengal lost their bargaining power.

Then came the IRDP, NREP, etc the poverty alleviation programmes carrying forward the GR technology in the 1970s and early 80s. Although Hanumantha Rao's observation (1985) based on the NSS data noted that these poverty alleviation programmes have succeeded in bringing about appreciable decline in the proportion of rural population below poverty line, their performance is far less impressive for the SCs and STs, the traditionally weaker sections. Similarly A. K. Bagchi in (1982: 77) noted that although for nearly two decades the GR measures have been experimented by the Indian states, in most parts, the GR has failed to raise the incomes of rural poor appreciably and to contribute substantially to their effective purchasing power. Even the ILO 1977 report says that the real earnings of agricultural labourers and poor peasants have been lower in early 1970s, compared to 1960–1961 in several Indian states like U.P., Punjab, Bihar and Tamil Nadu.

Thus, the GR technology along with other factors had handsomely contributed toward the class formation in rural India.

It would not be inappropriate here to make a reference to recent controversy involving the use of Biotechnology based seeds named Bt. Cotton for farming and the suicide of farmers in large numbers particularly in Andhra Pradesh and Maharastra, Gujarat, Karnataka. Anti-sci, anti-tech activists and scholars have been crying foul not only against Bt-Cotton but also against Monsanto the bio-tech MNC and biotechnology itself. Bt-Cotton project in India is said, to be a 'Scientific-Fraud' conducted by Monsanto Mahyco. Some said 'Bt-Cotton technology Belies Promises'. The GM seeds and its MNC are directly blamed for the large number of suicides of small and marginal farmers committed in last couple of years. But the summary of several empirical studies conducted among the cotton farmers of AP, Maharastra and Karnataka revealed that the immediate causes of farmers' suicide were, (1) growing indebtedness to the money lender-cum-traders, (2) adverse



pricing, (3) competitive market situation, (4) low yields and (5) growing costs of cotton cultivation. But the antecedent causes of the suicide were consecutive crop failure/low yields and growing costs of cultivation. The antecedent causes are related to the promises of the Bt-Cotton and its MNC Monsanto Mahyco as it implies failure of the biotechnology based seeds. Apart from the large number of suicides by farmers, what is relevant for us here is the other implication of crop failure and peasant's indebtedness. This other implication is equally serious. Because apart from the large number of farmers who killed themselves there is good number of small and marginal cotton farmers who because of crop failure and indebtedness have now lost their lands as well as livelihood leading to their depeasantization and conversion into daily wage labourers (Kameswara Rao, 2006, Sharma A. B., 2002; ISIS press Release, 2005).

Of course attributing very low yields, high costs of seeds, high costs of pesticides and other technical inputs to failure of the biotechnology is in fact heavily contested by the MNC and it is not conclusively established by the experts either. As the same technology works fine as per its promise in USA and other western countries it should be working fine in India too provided its specification are met. Even if we agree with the antecedent cause of peasants' suicide and their loss of land holdings, there are other complex factors that have come into light too, i. e. (i) the promises made were not that of Monsanto but that of the marketing company of Indonesia named Mahyco, (ii) only around 9 % of the GM cotton seeds sold in India were legal under Bt-Cotton name, the rests, particularly those sold as 'Navbharat Seeds', and others were illegal, (iii) that the Bt-Cotton seeds were hurriedly introduced to Indian market without sufficient step-by-step field trials before full scale commercialization.

Thus the Bt-Cotton fraud lies elsewhere not in the technology, may be in a rogue marketing agency like Mahyco which made false promises or may be in the illegal seeds sent to market that were adulterated and rendered spurious, etc. Therefore, state governments in India have not banned Monsanto seeds so far. On the contrary area under its coverage in the country has multiplied. Now Bt cotton in India has much more acres of land under its seeds than before.

## (C) S&T based Development as Triage (during 1980s and onward):

The other way in which S&T affect the social structure directly is through the developmental process. As I have already stated, the modern notion of development is considered to be scientific as it is an offshoot of scientific planning. Thus it is legitimized by science. At the same time development involves extensive use of intensive scientific and technological know-how.

On the contrary, modern S&T have become more desirable today because they have made development possible. The two provide mutual reinforcement of each other. As S&T are responsible for the difference between traditional and the new status in human living that development promised to offer, S&T encouraged a specific development strategy. And modern S&T essentially refer to a particular kind of resource utilization pattern and subsequently a kind of life style which is identified to be typical to modern development process. Thus development has come to be synonymous with better quality of life. Since development is assumed to be an universalization of western economics tradition, western style of consumption and living are considered necessarily to be better quality of life.

Development through industrialization or other scientific projects in an area will cause underdevelopment elsewhere as it happened in the case of Europe. Becoming developed involves the cost of others who are underdeveloped. There is a constant flow of resources from the traditional sector to the modern sector. The resource demands of the development process are often satisfied by diverting resources away from survival needs and life support functions. Therefore, the growth and productivity of the modern has to coexist with the poverty and backwardness of the traditional.

The effort to produce even a limited western style 'development' had to be executed against the survival capacities of millions who would insist on remaining outside the system. Such development would be premised on undermining both their life styles and rights to resource. Thus development inevitably became officially sponsored triage (Alvares, 1992; 7).

Also growth of one sector within a society would cause underdevelopment in other related sectors. Thus, with the growth of machine based industrialization not only crafts were lost or were eliminated in the colonies, but we also witnessed the transfer of all but the primitive jobs to the cities. Much of the rural resources/and products also were lost to the lust of the urban population. Examples of this kind are not in short supply. Development comes hand in hand with displacement. Some insightful examples would not be far fetched, such as: the replacement of mother's milk by baby food fed through bottles, replacement of Indian 'gur' (*jaggery*) by modern white sugar and the like, although value of food content in the former over the latter is much higher. The other meaning of displacement is much more important and lies very much in the context of development. It refers to the displacement of the tribals /natives from their natural habitats by the introduction of modern scientific developmental projects in the naturally rich interior areas. Some of the micro-protest movements that India witnessed during the last two decades are in fact protest against various types of development projects causing **large scale displacement** of rural/tribal populations. Many of these movements have been marred by violence. Some of these micro movements could be identified as, Save the *Gandhamardan* Hills (against the mining project of Balco in Orissa), the *Narmada Banchao Andolan* (against the river valley project on Narmada river spread in Madhya Pradesh, Gujarat, and Maharastra), Koel-Karo protest movement around Ranchi against the hydro- power project (in Jharkhand), Protest against Kaiga Nuclear plant in the Western Ghats, *Tehri Dam Andolan* (against a hydro-power project in Garhawal), *Chilika Banchao Andolan* (by fishermen against commercial Shrimp firming project of Tatas in the Chilika Lake of Orissa), *Baliapal Ghati Pratirodh Andolan* (against the National Missile Test Range in Orissa), *Kashipur and Lanjigarh* protest movement (against the mining projects of mining corporations like Utkal Alumina.../ Hindalco and Vedanta respectively in Orissa) and now the Nandigram Protest Movement (against the SEZ based Chemical industry hub) in West Bengal. The history of displacement in independent India starting from Damodar Valley Corporation (DVC), Hirakud dam, etc have been agonizing. A large section rural and forest dwelling communities have been economically sacrificed in the name of developmental projects (in the absence of an effective Rehabilitation and Resettlement policy).

Thus, 'development has meant nothing more or less that the displacement of one set of ideas, peoples, cultures, processes and realities and their substitution with another set designed by modern S&T' (Alvares, 1992: 69). Therefore a developing society within itself also remained divided as scientific and the non-scientific. This is a great divide indeed and S&T forms the basis of this dual society.



S&T as the active partners of development process have contributed largely towards the current environmental crisis which has two dimensions: one is the ecology destruction and the other is the environmental pollution. It hardly needs to be emphasized that in both the cases the poorer sections in developing countries are invariably adversely affected to the extent of loosing livelihoods and being vulnerable to hazards of pollution.

The colonial domination systematically transformed the common vital resources into commodities for generating profits and industrial growth in the West. The access of European industries to the natural resources of South Asia and other colonies, to a large extent, supported the first industrial revolution. But with the collapse of the international colonial structure and the emergence of sovereign countries, this international conflict over natural resources took a different turn but continued to prevail. Because the resource use pattern in the West continued as it is typical to the western type of development. Today the conflict over natural resources has given rise to social protests and tensions in the developing world.

Vandana Shiva (1998: 1991) has analyzed with clarity, how 'ecology destruction is an obvious cost for economic development, through the extensive use of modern technology, as it is the magic wand that transforms the natural resources into forms of luxurious consumer articles in the super market'. When S&T were used by contemporary societies to enhance men's access to natural resources these also allowed the utilization of natural resources at extremely high rates. Matched by the resource utilization tradition of development, modern technology is highly resource intensive and wasteful too. To prove the wastefulness of modern technology Shiva (1991: 38) explains how in the Solvay process for the production of soda ash, only 40 per cent of the raw material (that is sodium chloride and lime stone) is really utilized and 60 per cent of it goes as waste which pollute land and water resources. These resource intensive technologies operate from the industrial enclaves with enormous amounts of various natural resources extracted from diverse ecosystems that are usually far away. This long, indirect and spatially spread process of resource transfer made possible by energy intensive transportation, leaves invisible the real material demands of the technological processes of the development (Shiva, 1991: 33). The benefits of economic development do not percolate down to the poor, but the impact of development on the poor is the loss of their resource base meant for survival.

The unfortunate part of the development process is that it has given rise to a cult of consumerism which is highly destructive of the environment. Those who have access to all the fruits of S&T have been the conspicuous consumers. These are the consumers of the technologically developed societies of the West and the higher income groups of the developing societies. Imagine the situation of a western consumer, whose beef and fruits come from Latin America and Africa, peanuts from West Africa, coffee from East Africa, tea from India, prawns from the Asia-Pacific, timber from Asia, Africa and South America at throw away prices in hard currencies. Modern S&T are used by the rich and the powerful not only to dispossess the poor of his survival resource base, but also to undermine subtly the confidence of the poor in their own resources and resource use patterns. A classic example of this could be the hypocritical attitude of modern medical professionals towards herbal medicines, when majority of drugs in the U.S. market today are, derived from plants or plant based raw materials. Drug firms do take great care to screen the pharmacological properties of herbs. Pharmaceutical firms try to identify the active ingredient and the chemical analogue of every new found herb. This is manufactured, packaged, marketed and prescribed by the medical profession. Yet medical practitioners dismiss herbal medicine as outright

quackery when not packaged by pharmaceutical firms and even do not study the medical system based on it. Neither do drug companies make any effort to promote herbs directly.

Being resource intensive by nature and being the active partners of development process modern S&T have destroyed various ecosystems of the world by intervening in the processes of nature. Following Carolin Merchant, Vandana Shiva (1988: 22), and others have found the eco-destruction capacity of science to be inherent in its epistemology as modern science is said to be reductionist. It is reductionist because first, it reduces the capacity of nature to creatively regenerate and renew itself to its manipulable potentiality and secondly because it sees all systems as made up of some basic constituents that are discrete and atomistic. Further, it assumes that all basic processes are mechanical. Nature and society have been socially reconstituted by mechanistic metaphors, in contrast to the organistic metaphor in which concepts of natural order and power are based on inter-connectedness and reciprocity. The mechanistic metaphor of nature is based on the assumption of its separability from man and separability as well as manipulability of its parts. The epistemological assumption of reductionism is related to its ontological assumption 'that allows the knowledge of the parts of a system to be taken as knowledge of the whole and separability allows context free abstractions of knowledge to create criteria of validity on alienation and non-participation, then projected as objectivity (Shiva, 1988: 22).

Similarly, natural resources are treated as isolated, non-interacting collection of individual resources. They acquire value only in the context of the marketability not otherwise. Only those properties of a resource system are taken into account which generates profits through exploitation and extraction; properties which stabilize ecological processes but are commercially non-exploitative are ignored and eventually destroyed even though they are functional to the ecology at large. Hence the view that reduces the nature to its parts, and takes no account of the relationship between parts and structure and function of the whole system, is reductionist. Nature is to be understood as a cyclical process that renews itself and thereby functions as a life-generating mechanism. Further, it is to be recognized as a life-supporting system. Mankind has to benefit from the natural processes only in maintaining them, not in violating them. Nature is to be understood as a living ecological system and not as a mere embodiment of discrete facts, detached from their eco-systems, as resources in the context of market. Feminists scholars like Shiva (1988) have articulated how Indian women, who are still embedded in nature, are the worst affected lots in the ecological destruction. Modern science has a philosophical foundation which is anti-ecological too. The genealogy of modern science can be traced to the tracts of Francis Bacon, James Hobbes and Rene Descartes. Bacon is the father of industrial science who founded the experimental and utilitarian tradition of modern science. Bacon viewed science to be the means to acquire control over the environment. In Baconian philosophy nature almost appeared to be an awesome foe to be tamed and tortured to yield its secrets. Hence nature must be made a 'slave' and bound into service, 'put into constraints', or nature must be subjugated, 'coaxed, vexed, and tortured'. It has to be 'moulded' by the mechanical arts. This is a major attack directed against nature. Similarly Bacon's scientific knowledge and mechanical inventions do not merely 'exert a gentle pressure over nature's course; they have the power to conquer and subdue it and shake it to its foundations'.

But the mechanistic philosophy of Descartes (for details, see Merchant, 1982: 234) sounded the death knell of naturalistic philosophy. Apparently a proper understanding of nature particularly of eco-systems is hindered by the very nature of mechanistic world view and reductionist method. These also made possible the human manipulation and control of nature. And finally, Hobbes the individualist political philosopher forged the



link between science and political power and thereby clasped science to legitimate domination. Therefore, today in the given economic order of unequals, S&T have rendered the real owners of the natural resources, the non-owners, dependent and subordinate and have also molested nature through developmental projects.

We may go back to the initial issue of science, technology and environment crisis within the development process. The second dimension of the environmental crisis is environment pollution which is too obvious to be discussed at length. Within developing countries the developed sector, meaning the industrial sector, pollutes land, air and water indiscriminately by its fuel emissions as well as by the toxic industrial wastes. No less polluting are the modern means of transportion on land, air and water. S&T have extended the arms of the developed countries so far that even dangerous industrial wastes from these developed world are dumped in the territories of the developing world.

The tragedy caused by Bhopal-based Union Carbide's gas leak (that killed more than 10,000 and physically impaired 86,000 people) in 1984 is a familiar example of the violence inflicted by modern technology. The case of Bhopal gas tragedy can be pushed aside as a unique accident but such tragedies of lesser magnitude occur every now and then. Claude Alvares (1992: 19–29) has reported the cases of acute environmental hazard caused by modern industries in remote villages of India (such as: The Kabini Paper Mill in *Nanjangud* subdivision of Karnataka, the tanneries of North Arcot district in Tamil Nadu, the Orient Paper Mills at *Amlai* in Madhya Pradesh, the industries of Patanchurur and Bollaram industrial estates of Andhra Pradesh). Where the villagers are not only exposed to dangerous toxic industrial wastes but also many of their lands are rendered almost useless depriving the farmers of their livelihood (e. g. frequent ash pond leaks 1998 & 2001, from CPP of NALCO, Angul plant has degraded large tracks of cultivable land of farmers). However, examples of this kind are fast becoming everyday matters.

## (D) Information and Communication Technology (ICT) Revolution in India (1990s onward):

In a recent study conducted by Deepak Kumar (2006: 90–96) in an MP village named Nagda about the social change a government funded IT project called *Gyandoot* has brought about. The author based on his empirical data points out the kinds of services the villagers get from this Gyandoot project. (Under which the village is provided with computers with LAN facility and an operator in an information centre called Soochanalay). The most beneficial and noteworthy services the villagers received from this project on payment of a token fee could be the following:

1. Information on Mandi prices of various agricultural products in all near by cities that enables the peasants escape the middle man and get more profit,
2. Information/documents about Land Records / Maps and ownership certificates to enable acquire loans/ have a sale,
3. Online registration of applications for obtaining income, caste, and domicile certificates including the loan passbook,
4. Public grievances redressal by lodging several complaints about teacher's absence, mid-day meal, pump disorder, disbursement of poor quality seeds / fertilizers and government employee related matters like, their PF sanction, pension, etc,

5. Getting school Board and Inter Board examination results on line right in the village itself by rural based pupils,

6. Getting online Transfer list and orders for state govt. employees,

7. Facility for auction (Gram Haat) of land, agricultural machinery / equipment, bullocks and other domestic commodities,

8. Access of villagers to a matrimonial alliance site, exclusively created for the villagers to help them find the right match for themselves or for their wards, and

9. Educational Queries *(Sawali Ram)* to promote inquisitiveness among children.

This impact of *Gyandoot* project articulated by the author seems to be like a fairy tale that Indian villagers have the world of information and the whole administration on their finger tips. Nevertheless, this may be an idealized and exaggerated state of affair but this could be the trend of state of things to come. This may not be the volume but the kind changes that are awaiting. This is empowerment of the masses through information. But these are not social structural changes to be called as social change. What structural implications these have are yet to be articulated.

Subsequently the author (2006, 133–160) analyzed the digital divide in the village in terms of use of the (*Soochanalay*) information centre for getting necessary information through the computer-LAN facility. The findings are as per the expected line, for, it was found that users are predominantly higher caste people, who have high school and to some extent college education and also these are the people who are the landed lot (comparatively). The dominant sections of these users are the rural based/rooted school teachers and state government employees. There are small evidences of village poor (SC and ST population) being benefited by the *Soochanalay* but this is too meager a number. Thus ICT in the village Nagda of MP strengthened and reinforced the existing social divisions and old social order, concludes Deepak Kumar (2006). These findings are very much in conformity with my general assertion that S&T are value neutral and by themselves do not create inequalities. But when used in an already existing stratified frame work it would proportionately benefit the different strata.

In continuation with my argument in the line of S&T and social stratification, I am to examine further some visible social impacts within the IT turned ICT revolution in India.

The rise of Indian IT and software industry during the 1990s has been the most spectacular achievement of Indian Industry. This industry grew at an incredible rate of 50 % per annum during the whole of the 1990s. Being export oriented it has earned 75 % of its revenue from exports alone. This industry in the year 2007 had nearly 1 630 000 and in the year 2008 had nearly 2 000 000 employees. The IT revolution in India has not only given rise to new class of transnational capitalist, but also, more significantly, a new class of workers/professionals that is fully knowledge-based.

***Emergent New class of transnational Capitalists:*** It is now well known that a new class of entrepreneurs have emerged out of the IT revolution in India. As noted by Upadhya (2004, 5143–5145) in her study of Indian software industry, most of the founders of software firms (SMEs) in India had middle class origin who had built on their cultural capital of higher education (usually through engineering education) and acquired social capital (knowledge and business networks) through their professional careers. Their social capital enabled them to make use of the trust and cooperation of their professional networks, for making innovative business advancements, because their social capital could reduce the



transaction costs, bureaucratic procedures and even corruption. Thus the combined virtue of cultural and social capital engendered a class technological capitalist in Indian IT sector. This class of capitalists is not only driven by high need achievement orientation but also high level of technological innovations. They could ride innovation driven business that has flattened the technological world, at least in the IT sector to a great extent. This class of IT capitalist is also distinguished by its global linkages. Not only that many of them had studied / worked in the USA /abroad but also their business were, (i) greatly dependent upon foreign contracts (particularly US) and (ii) most of them acquired foreign funding either directly or through foreign Venture capitals (which were mostly from USA, particularly the Silicon valley). This class of entrepreneurs is distinct from the traditional Indian capitalist class (Seth Jis leading family business) and corporate houses like Ambanis, Bajaj, Birlas, Godrej, Goenkas Kirloskar, Singhanias, Tatas, etc.). These are also first generation entrepreneurs. As the offshoot of liberalization of the Indian policies and globalization of the economy this bourgeoisie is more adaptable to MNCs. Instead of being wary of the presence of the multinationals in the IT sector, this class could find a synergy with MNCs and have learnt to benefit from their presence. Therefore, this class, first being the offshoot and later being part of the transnational IT business is the strongest votary of globalization. By virtue of creating enormous employment and profit this industry has influenced Indian economic and industrial policies greatly during the last two decades. Upadhya (2004) calls them the 'icons of the resurgent India'.

***Emergent New Class of elite Workforce:*** This transnational entrepreneurial class has emerged in tandem with a transnational labour regime which has generated a new class of IT workforce in India.

In this context of IT workforce extremely pertinent are the notions of '**techno-coolie'** and '**cyber-coolie'**. These derogatory terms refer to a new class of elite 'knowledge workers', emerging out of the global out-sourcing of services. Emergence of this workforce is not confined to India alone, rather is spread over several other developing and even developed countries like China, Singapore, Taiwan, Hong Kong, Philippines and Israel. Hence both the words refer to knowledge workers not merely that of India but to all such workers of countries who have become part of the international out-sourcing services. But India has a giant share in this.

***Techno Coolie****:* Software engineers or other IT professionals otherwise known as techies, of developing countries are seen as a new knowledge workforce that caters to the global informational economy. The workforce is highly flexible and mobile. These IT professionals called as *Techno-coolie* are mostly employed in the US, UK and other European countries like Germany, Belgium, Netherland etc or even many of them who are employed in home countries travel abroad very frequently for 'onsite' delivery of their services. 'These are essentially immigrants may be Indians, Chinese, Philippinos or Hispanic, engaged in low-end technical jobs. *Techno coolies* are also a grossly under paid lot. The geographically dispersed nature of the software outsourcing business makes physical mobility as one aspect of the migration. The developed form of ICTs even enabled part of the services to be delivered 'virtually'. Software engineers even located in home countries, along with colleagues and mangers spread over distant geographical locations work as 'virtual teams' to communicate among themselves and deliver to the customer abroad through computer networks. In this connection they make short foreign visits too. Usually a techno coolies are hired through

a practice called as '*body shopping'* from the developing countries because of the international subcontracting practices followed by large corporations in these developed countries to keep their costs low

Migration of techies from India to Europe although started in late 1980, it became significant in late 1990s, particularly due to 'Y2K' crisis. The important routes of this migration from India by the techies were three. The first one was through an arrangement called 'Body Shopping' by which Indian techies were sent on short contracts to work on the customer's site abroad. (2) The other arrangement was through outsourcing by American/European firms through Indian software service providers who had a team of techies working on the project at home and another team working onsite at the customer's venue abroad. Earlier TCS, Infosys, HCL etc. large IT firms were engaged in Body shopping and had offices both in India and US/Europe. (3) The third arrangement was migration through the Indian subsidiaries of European MNCs like, Philips, R. Bosc, Siemens, etc.

1. Through Body shopping: This arrangement was not so encouraging for the Indian techies as they were engaged on the customer's site on low-end maintenance jobs with low salaries. Their employment conditions, compensations and nature of contract are determined by consultants (Indian agencies) and their works were managed by the customers. The techies were usually on a contract with the consultant company to be paid on hourly rate other than the travel accommodation and maintenance allowances. The duration of the stay abroad is specified in the contract. Usually the techie cannot break the contract with the consultant for greener pasture abroad as they had to pay back heavily. The Indian consultants were basically subcontractors suppose to provide mere 'bodies'/engineers with specifications to the MNCs.

2. Through Outsourcing companies: Those techies travelling abroad by outsourcing arrangements through Indian service providers like TCS, HCL etc. usually have their base jobs in India but are sent abroad to the client's site for a certain period. They are managed by their Indian service providing agency and not the client; mostly they get the Indian salary, with extra money for Europe/USA. The techies could make good money out of this but again carried onerous contracts or bonds with Indian agency not to join the job of the client or anybody in the client's country. Further on return they were bound to work with the Indian agency for a few years, and the like. Violation of the bond invites a hefty fine that may drive the techies bankrupt.

3. Through MNC subsidiaries: A good number of Indian engineers go abroad to work through their parent subsidiary companies of US/European MNCs like Oracle, Philips, Robert Bosc etc. These are employees of the MNC subsidiaries in India called software development centres and are in fact better placed compared to the earlier two mechanisms. They go on short/ long term assignments and are comfortably placed abroad, as employees of the subsidiaries they are provided with housing, good working conditions, allowances, etc. Even they have to make little or fewer adjustments in terms of work culture, etc. Often they are housed with employees of parent MNCs in block apartments abroad.

4. The other category of mechanism for the techies was to get employed directly by US/European companies leaving the Indian agencies' contractual arrangements behind. Although most of them had come under 'body shopping' arrangements for onsite delivery, but have shifted away. Their salary and employment conditions are better than first three types.

Apart from predicaments related to mode of recruitments, these Indian techies are marred by prohibitive immigration laws and regulations. It is well known that for Indian techies, obtaining visas, work permits and residence permits for European countries is much



harder than for the USA. Upadhya (2006) in her study among Indian techies in Netherlands, Germany and Belgium have tried to analyze their plight in terms of work culture differences, as victims of European stereotypes about Indian techies, culturally embedded communication patterns, poor time management, inability to adapt to multiculturalism of virtual teams and dim career prospects in Europe . These apart, these techies are to 'negotiate the quagmire of immigration laws and rules (which are often humiliating) to maintain themselves in Europe and have to chew the common images of immigrant workers, diluted with racism, held by local people. They too struggle for an identity of a professional/knowledge worker as different from unskilled working class immigrants (from other small poor countries). As if these were not enough the Indian techies have to withstand the anti-outsourcing sentiments in Europe and USA and a consequent fear of loss of job. Their isolation and social seclusion add to their owes.

Thus the Indian techie struggles hard not only to acquire the European work culture, multiculturalism, etc but also engages himself in a reconstruction of his identity and self to relate to a foreign society.

***Cyber Coolie:*** Today the word *cyber coolie* refers to that growing workforce which comes under the IT Enabled Services (ITES) like, call centers, medical transcription and business process outsourcing. This workforce emerged out of the policy of 'off shore outsourcing' of services followed mainly by a few developed countries like the USA, UK and Japan. European powers like France and Germany do but their scales of outsourcing of services are very limited. And India being an English speaking country is favourably placed to be at the receiving end of this international outsourcing of services from USA and UK. Like the *Techno coolies* the *Cyber coolies* are also grossly under paid. When a 'cyber coolie' delivers his off-shore services through internet being present in his home country the 'techno coolie' delivers his services abroad right on the cite of the client being present there.

These low paid technical workers are hired from developing countries to do low-end, low intensity software jobs. They are employed on a contractual basis only. Even most of the BPO jobs are out sourced from developing countries as part of the policy of international subcontracting by large MNCs. If the large MNCs in the manufacturing sector outsourced their processed raw materials, components and even some times semi finished products from developing countries in the 1970s and 1980s, by shifting their manufacturing units from these leading industrial countries to developing countries, in the 1990s and 21st century the large corporations in the service sector in those industrial countries are outsourcing their services by low cost manpower from the developing countries. This is the consequence of the growing competition among MNCs in the developed countries and their efforts to reduce costs.

The word 'coolie' (whether *techno-coolie or cyber-coolie*) has certainly a contemptuous meaning and is used in a derogatory sense. Coolie, ***aka,*** a poor fellow, dressed in red, scurrying after us carrying our heavy luggage on his head as we board a train, all for a few pennies. It is indeed difficult to trace the exact origin of the word cyber-coolie/techno-coolie. But certainly the word was coined by the Indian left wing intellectuals who have been against free trade. It is also true that the leftist have been trying to trade unionize this growing work force which the work force itself has not entertained. Hence, this contemptuous attribution. The other source of the word 'cyber-coolie' is the British critics of the phenomenon who are yet to free themselves from the 'Raj' hangover. British economy today being more a service economy deals more with financing, banking and insurance than with

manufacturing. Hence it needs 'back up services' in these areas which they outsource from its ex-colony, India which is also English speaking. And this is also true that Unionists in Britain do consider these outsourced low-end jobs by Indians as job snatching. Therefore, this envious contempt.

These knowledge-workers emerging as a distinct occupational category in India is of very recent origin, may be a consequence of India's globalization. As a distinct occupational category it has certain characteristic features and it is fast developing a subculture for itself. Most of my formulations here are based on information/publications in the internet. I also borrow the findings of a study conducted by Babu P. Ramesh (2004, 492–493) on BPO workers of India. The empirical study was conducted among a sample of 277 customcare agents from six call centers of BPO companies in Noida, Delhi capital region. The BPO industry in India alone currently employs little more than 500000 так? according to NASSCOM (2007) (BPO industry includes the employees of the call centers who work over phones and business process offices who work over webs). (See, Appendix Table. II for data on India IT industry employees)

These knowledge workers are all young, educated and convented Indians who work in call centers and outsourced business processing offices to cater to American and British multinationals. They work through the nights, for good reasons that night in India is day time for their clients in USA. Since they work through the nights Harish Trivedi (2004: 1) even calls them a *"Chowkidar*" a derogatory word meaning night guard. They work through cyber phones and cyber webs to deal with their overseas clients. They speak in an American accent which they have painfully cultivated. As their Indian accent is neutralized, their personality, biological clock and identity also have been neutralized. Because they conceal their real names and country of residence while dealing with the clients. Often they have to introduce themselves as Pete/Greg/Jane from Atlanta/Ohio etc. Thus they are faceless workers with pretentious identities who deal with invisible customers/clients located on the other side of the globe.

Many of these BPO workers not only work for very long hours but also at odd hours. Many find that they have little social life left, as they work in nights when their families and friends are at homes. Some develop long term sleep disorders, some take so much verbal abuse, day after day, from irate and racist Americans that they actually need psychological help which now some call centers, have learnt to provide for (see appendix Table-II for Indian BPO Stress factor).

These young people are the scions of middle class urban parents, mostly graduates, computer savvy and educated in convents or public schools from where they have acquired a fluency in English and some times possess a technical or science degrees but all of them long for an exposure to western popular culture. This work force in spite of its long hours of work, even in odd hours, also works in the weekends. But this is a grossly under paid lot. This is why India is seen as an outsourcing threat. The cost of an Indian BPO employee is seven to ten times lesser than his American counter part in ITES business. True that, there exists a large pool of English speaking low-skilled manpower in India. And this makes India a western corporate attraction. The key is low wages.

The organizational structure of call centers is basically dualistic, consisting of a core/permanent set of employees and the periphery/temporary workers. All call centers agents are periphery workers, who are substitutable, while team leaders and managers make the core group. The long term career prospects there now are bleak or virtually non-existent. The dualistic work force model allows the firm to regulate the work force and nip in bud



any sign of trade unionism. Trade union is a strange word for this work force. The labour practices that call centers follow are even much older. Because work is monitored on the spot and even after working hours with the help of specially designed software, computer network and closed circuit cameras. All interactions of these employees in office are continuously recorded or taped and randomly checked by the manager. The most of surveillance recorded at work is even comparable with situations of 19th century prisons.

Mistakes at work lead to immediate warnings and those are recorded in 'warning cards' that form part of the daily ratings of agents. If an agent commits three errors in a day he/she gets a zero rating. Three consecutive zeros lead to counseling or even dismissal. Availing leave without prior notice/consent is considered unauthorized and could be reason for termination. So the call centers by and large practice a hire and fire policy. As it seems, there is no modicum of Labour Law in this sector. Thus the service conditions of this work force are very poor. But on the contrary its working conditions are extremely congenial and much superior to those in the manufacturing sector. Their office premises are very clean and fully air conditioned. They are provided with free meals, free transport (car pick-up and drop), regular staff entertainment, a concierge service that will book cinema tickets for them, an ambulance waiting at the bottom of the building if they are fallen ill, etc. Apart from less challenging jobs like telesales and customer services they do render more challenging services by providing value added 'back office' support in the area of banking and insurance too. The monotony of work and stringent service conditions are camouflaged by the projection of 'work as fun' — by introducing cafes, popcorn booths, Ping-Pong tables, internet kiosks, gym, clinic, etc into the office areas. In this comforting working environment, quotas for calls or emails are successfully attended. Besides, this particular working environment, a reasonably good salary (Rs. 10,000/ to 20,000/– 25,000/ per month), use of latest technologies, young and educated peers, all make these knowledge workers believe that the job they are doing is of an executive/professional.

That apart, this is a highly disciplined work force. And because of its education and predominantly middle class origin this turned out to be a docile work force with high level of efficiency. But unfortunately this highly productively docile work force is bereft of labour rights and job security. As a distinct and new occupational category this workforce is fast developing a sub-culture of itself. The English they write is of a different variety more of American spoken English type (with abbreviated forms of expressions) like the nature and the types of products they market or products they do value addition. They represent a subculture that emphasizes traits like, ***low cost***, ***instant satisfaction***, ***use and throw away, take it or forget it, minimum-quality assured, etc.*** Even they cherish the Mull Culture (Food, entertainment and shopping all in one building) because of their night duties.

It is precisely because of their perceptions of being professionals that holds back these elite knowledge workers from forming trade unions. Left wing politics in India has been desperately trying to penetrate its trade unionism into this sector for last several years. Another important reason why these workers are disinterested with trade unionism is that they do not intend to continue in this job for a long time, rather they consider this to be a stepping stone to migrate or shift the job. This kind of job perception by the ambitious young work force obviously finds the notion of unionism incompatible with itself.

A few internet based articles on 'cyber-coolie' by Harish Trivedi (2004), Prafulla Bidwai (2003), and Ranabir Ray Choudhury (2003) etc. have provoked strong reactions from among this work force. A frustrated Narayan Ram Hegde of Union Network International (a global alliance of 900 unions) when miserably failed in his effort to induct very few of the

knowledge workers into their trade union framework, noted that 'these young people have a negative image about unions. But they are more like cyber-coolies. Hopefully they will be convinced over time'. The debate has certainly created some hit in the net.

These young and educated workers claimed themselves to be 'cool professionals' against the attribution of being cyber-coolies. In the debate they too displayed their contempt for left wing trade unionists. Here are some of their responses:

> "Cyber-Coolies, the term trade unionists and leftist types use condescendingly to describe outsourcing professionals only reveal their contempt for the dignity of labour. And for those claiming to represent the cause of labour that is already a major disqualification".

> "The cyber-coolies argument is a load of crap, plain and simple. Working conditions as a rule are already better than what exists in other offices… Further most of the top software/BPO companies have a very good feedback system in place. Hence what is the need to go on strike, or have a bunch of gangsters speak on your behalf, when you can always just quit and join a competitor? At this point it is an employee's market, not employers and software companies are aware of it. The amount of begging my boss did in an attempt to prevent me from leaving to go do my MBA was almost shameful. There is no difference between unionists and a bunch of gangsters…" (TTG on Sept. 26th 05, at 13:09).

> "The left wing intellectuals who coined the term cyber-coolie were certainly not keen on free trade. But they do not mind selling their silly novels and social analysis of Indian society in western market but have an issue with people making a decent living while performing support work for MNCs. It is widely known what unions have done to slow down economic reforms keeping India in perpetual under performance mode for the past decades. This is just another step in trying to curb the fast growing BPO market" (Chandra Dulam on Sept. 27, 05 at 00:50 hrs.).

> "First of all a 'cyber-coolie' has a job and puts food on the table, so that ain't a bad thing. Secondly, he actually works (gasps!), something that the union idiots have never done their entire live…" (Guru on Oct. 2nd, 2005, at 14:50 hrs.) (The Acron, 2005)

In a website entitled 'Dancing with Dogs: Interesting debate' (Aug. 18. 2004) carrying this debate one finds some of these cool young professionals loosing their cool. Not only they did heavy left bashing but also literally lead a counter offensive against these left wing Indian intellectuals for their contemptuous writings.

Even a popular columnist like Gurucharan Das noted that 'Trivedi's depictions are truly bizarre. What he sees as exploitation by MNCs, the young people on the contrary see it as an exciting chance to make a career in global economy... The minds of these 'cyber-coolies' seem to be de-colonized whereas poor Trivedi is stuck in a post-colonial past'.

Thus there exists a perceptual difference between those of the left wing intellectuals and those of the elite knowledge workers. Of course there prevail an ambiguity with regard to the objective conditions of work of these knowledge workers. The objective conditions that are goading an intellectual to perceive the knowledge workers as 'coolies' are countered by another set of objective conditions that go in favour of the agents perception of themselves as 'Cool professionals'. May be it is a new class of elite technical workforce which by its objective conditions make a class in itself, but in order to make a class for itself it need to possess



a subjective consciousness of their being so. Thus an objective class is yet to be matched by a subjective consciousness or an objective class is yet to be converted into a subjective class. Therefore unless and until a class in itself becomes a class for itself, it would be difficult to treat them as cyber coolies. As in the early stage of industrialization the sociological problems of industrial workers were, inadequate wages, long hours of work (bringing surplus value), poor work environment, job insecurity, etc and in a later stage the same got changed to alienation (loss of skill and self), technologically deterministic human behavior, industrial accidents / health hazards, unionization, participatory management and the like, with the advent of post industrial society (part of the economy is knowledge based) the sociological perception of the problems of the knowledge based workers is bound to be different as the very nature of work has undergone change. This new sub-class of new technical work force is an off-shoot of the India's recent IT revolution which is still evolving fast. As slowly these new elite workers are coming under the fold of trade unions, their service conditions and salaries are improving. BPO as a phenomenon in India is going to stay, it is not a very transitory phenomenon. Rather it is fast expanding and once stabilized as a feature of Indian economy the career prospects in BPO industry are going to be brighter like that of their prosperous cousins in the software sector. It must be kept in mind that this Indian workforce is today envied in the USA and UK as job snatchers.

But the more enviable job snatchers are another new budding class of highly paid employees engaged in the knowledge based outsourcing industry of India. These are today known as KPO (Knowledge Process Outsourcing) professionals. These are true professionals like graduate engineers (in areas of CAD, Biotech./Pharma.), MBAs, Charted Accountants, Economists, etc. They are engaged in off-shoring knowledge intensive business processes that require specialized domain expertise. Their jobs involve high-end processes like, computer aided simulations, valuation research and analysis, data integration, investment research, patent filing, legal/insurance claims, and management consulting etc. KPO industry may be export oriented like the BPO. But unlike the BPO industry that mainly provides the IT enabled services, the KPO provides domain based processes and business expertise that are more challenging and requires professional as well as technical expertise on the part of employees. The KPO industry in India has slowly grown to reach an export value estimated to be $12 billion by the end of year 2010 (UNI, 2005). This industry is making use of the vast pool of highly qualified but un/under employed Indian manpower. This too is a new and growing sub-class of Indian professionals emergent of the IT revolution.

## Conclusion

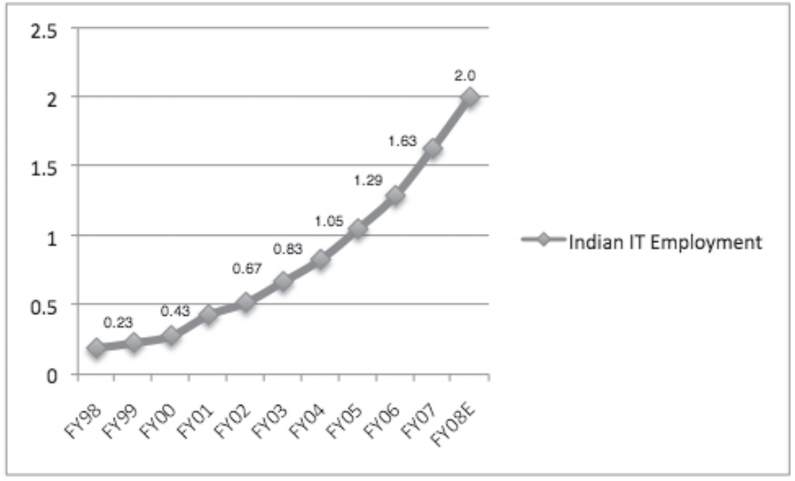
While talking about the class character of early science, eminent historian of science J. D. Bernal has noted that 'even 5000 years ago the identification of science with governing and exploiting classes had engendered deep suspicion about the role of science in the minds of peasants and the working of classes' (1969: 49). And Bernal had made it clear with examples (1969: 553) that it has been the operations of middle class interest that have again and again held up the advancement of science. On the contrary, it is the successful applications of S&T in war and the profitable applications in manufacturing business by bourgeoisie that have been the criteria for technical advances' (1969: 1246). 'The existence of class divided societies not only affect the material consequences of knowledge, it cuts deep into its roots...

It is in its basic philosophy that class influences have most affected science' (1969: 1247). Thus Bernal hinted this to be more of an epistemological problem.

True that S&T grew in the world of highly unequals. In modern nation states, being dependent upon the politics and the economy, S&T worked as an active partner of the two, devoid its autonomy and its inherent democratic and egalitarian values (Merton's), to be more used as a tool/instrument of change and profit. Particularly in the context of developing countries the role of S&T becomes less effective, unlike it is in the developed countries, because in a traditional society like India, the social structure had been more rigidly divided and inequality was already deep rooted. The access to S&T was and still remains to be unequal because the infrastructure/means required to use S&T is even more unevenly accessible. Hence the benefits of S&T reached proportionately to each class depending upon its place in the social strata. Thus S&T sided more with the developed section in a developing country who in turn used it to perpetuate their advantages by depriving the underdeveloped sections.

Hence in view of acquiring a more equitable effect of S&T relevant becomes the issue of reviving the indigenous (traditional) S&T and even the notion of appropriate technology or alternate technology that was hotly debated in the recent past. Reviving the issue of traditional S&T does not necessarily mean resurrecting the fossils. Their sustainability are in fact beyond doubt, if backed by supportive policy measures. Because as plural traditions (non-monistic) the traditional S&T are historically rooted in their respective societies and are more community based to be more equally accessible to the laities. Modern S&T need not be the panacea for all the societies even if it happened to be the case in the West.

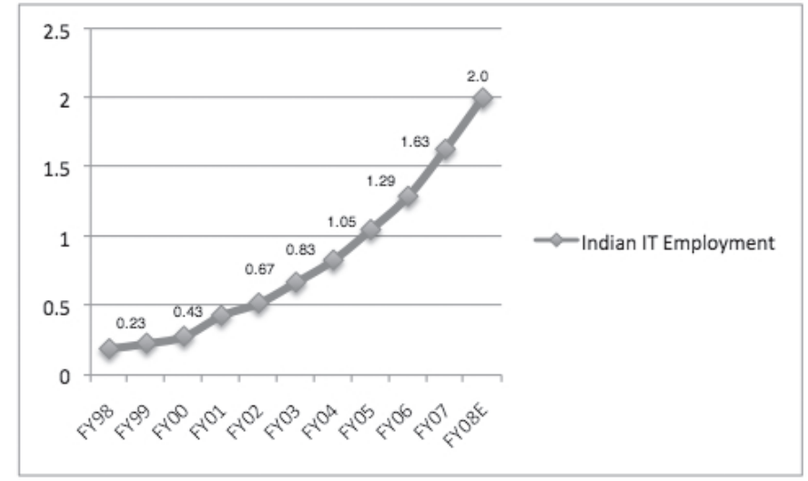
Table I
Indian IT Employment Figures-ITES-BPO Sector*
(in Millions)




**Figures do not include employees in the hardware sector.*
(Source: Indian IT/ITES Industry: Impacting Economy and Society, 2007–2008, p. 18. NASSCOM)



Table II
Indian IT Employment Figures-ITES-BPO Sector*
(in Millions)




**Figures do not include employees in the hardware sector.*
(Source: Indian IT/ITES Industry: Impacting Economy and Society, 2007–2008, p. 18. NASSCOM)

## Appendix

Table I
Indian IT Employment Figures-ITES-BPO Sector

| Sector | **FY 2004** | **FY 2005** | **FY 2006** | **FY 2007E** |
|---|---|---|---|---|
| *IT Services* | 215000 | 297000 | 398000 | 555,000 |
| *ITES-BPO* | 216000 | 316000 | 415000 | 553,000 |
| *Engineering Services and R&D and Software Products* | 81000 | 93000 | 115000 | 140,000 |
| *Domestic Market (including user organizations)* | 318000 | 352000 | 365000 | 378,000 |
| **TOTAL*** | **830000** | **1058000** | **1293000** | **1630000** |

**Figures do not include employees in the hardware sector.*
(Source: Indian IT Industry — Fact Sheet, NASSCOM, 2006–2007 updated)

Table II
Stress: Indian BPO Industry Stress Factors


(Source: BPO Employee Survey 2004; DATAQUEST)

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# Problems of technology transfer from CSIR laboratories to industry and policy issues in India and Korea

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This paper is an attempt to review the development of indigenous technology in India and Korea over the last forty years. It identifies the problems of technology transfer that the Indian national laboratories are facing. Indian technology does not have strong linkages with the industry with the result the utilization of the research is limited. Protection to domestic industry has been given so long that India could not catch up advances abroad. Whereas Korea made tremendous progress over the years because of its target oriented export policy. Korea became world leader in Semiconductor and left India far behind. On the other hand for India situation became worst after sudden liberalization during 1991 when the import of technology became liberal and indigenous technology had to compete with the mighty multinationals. Some of the industries vanished from the market due to tough competition. This is the high time that India should drastically change her research priorities to face the liberalization. What is required, that India should concentrate on areas where it has build up capabilities and excellence over the years, like software industry in computers. Secondly India should establish strong linkages with the industry to make value additions in the imported technologies.

***Keywords:*** science, technology, CSIR laboratories, National Development Research Corporation, technology transfer

## 1. Introduction

Achievement of self-reliance has been one of the declared goals of India's development plans. Since technology is basic to any process development, the self-reliance would not be complete without technological independence. This recognition has led to evolution of policies geared to strengthen local technological capability to ultimately achieve technological self-reliance. The industrial trade and fiscal policies pursued over the past four decades have contained policy instruments directly or indirectly concerning technological development. Besides these, the Scientific Policy Resolution, 1958[1], laying down the framework for development of infrastructure for technological development and the Technology Policy Statement of 1983[2], retreating the goal of technological self-reliance and providing a broad perspective and guidelines for the policy instruments have been enunciated.

The *modus operandi* of the technology policy thus evolved has been two pronged as in the case of industrial development in general. They have sought to provide to local technology/

[1] India is the first country in the world, which has passed the Scientific Policy Resolution by the Parliament under the leadership of the first Prime Minister of India Pt. Jawahar Lal Nehru.

[2] Technology Policy Statement was issued by the Department of Science and Technology in Jan. 1983. It emphasized the need to plan technical collaborations agreements in ways that would ensure effective transfer of basic knowledge.

skill from the imported ones on one hand. On the other hand, the local generation of technology has been sought to be accelerated directly and indirectly. The technological capability that has been generated as a result of these policies is no doubt immense and has brought the country near the technological self-reliance in a number of industries. India has even been able to export a wide range of technologies and projects to other developing countries. There are some other areas however, where technological self-reliance is nowhere in sight and the technological gap has in fact widened over the years, for instance in the microelectronics.

In 1991 the Indian policy has taken a sharp turn in favor of liberalization. Government had given advantages to transnational corporations to attract foreign investment. Whereas Korea preferred not to suddenly open the floodgates for transnational corporations, instead their operations were consciously regulated to minimize the negative feature and induce /force them to contribute to the growth of economy. Korea has taken a slightly different route by adopting target oriented export policy and entered into OEM[3] arrangements with advanced countries to promote the business network. With a meagre of $89 million in 1971 Korean electronics exports grew to $20.683 billion in 1992 an increase by a factor of 232[4]. Korea became world leader in Semiconductors.

In this paper an attempt has been made to probe whether transnational corporations in India are responding to liberalization by investing primarily for export market or for the domestic market and examines the future prospects for export-oriented foreign investments. It also explores whether entry of the transnational corporation is beneficial for the country.

The paper discusses the aims of the technology policy of India from 1960s onwards; problems of technology transfer from laboratory to industry; impact of liberalization on technological change in the Indian industry and Korean model of target oriented exports in the context of the government policy.

## 2. Aims of technology import policy of India from 1960s onwards.

Indian technology policy is determined by the self-reliance objectives of developmental planning. The basic approach has been an inward looking one, which in relation to technology transfer has meant the adoption of policy measures to prevent foreign ownership, to control productive activities, to unbundle technology package, to internalize skills and institutional structures, to acquire self confidence to meet its own needs increasingly and then to look outwards and extend co-operation in technology matters to other third world countries (Subrahmaniam, 1986).

In pursuit of this approach, administrative guidelines and procedures have been used for regulating transfer of technology on a selective basis. Every permissible import of technology is screened and approved by considering its mechanism and terms of the transfer and its impact on local technological development and balance of payments.

Indian policy concerning technology transfer has evolved through a number of stages. In the first stage, until 1968, foreign collaborations agreements were approved through administrative procedures based primarily on foreign exchange considerations. More detailed procedures for screening collaborative agreements including technical evaluation and registering

[3] OEM (Original Equipment Manufacturing) is a kind of arrangement with the foreign firms where they put there trade mark on Korean products.

[4] Dataquest (American magazine). September 1993.



were established in the second stage between 1969 and 1978. In the third stage initiated in 1978, a more liberal policy has been adopted. Out of more than 6,500 collaborations approved between 1950 and 1980, around 84 per cent of cases did not entail any foreign ownership participation. Technological collaboration (licensing) agreement has thus been the major formal mechanism used for technology transfer. (Subrahmaniam, 1986).

Simultaneously with a policy of selective imports of technology, Indian technology policy has been aimed at stimulating indigenous technologies/developments. The policy measures used can be classified as either compulsive or incentive. Examples of the first type are; 1) forbidding import of technology available locally without much time lag, 2) stipulation of target oriented indigenisation of production, 3) strict scrutiny of applications for renewals of collaboration agreements, 4) tax rebates and other incentives for implant R&D and 5) increased state outlays on strengthening indigenous science and technology (S&T) systems.

The compulsive instruments must have exerted environmental pressures on the firms towards moving rapidly on technology-independence continuum by assimilation and adaptation of imported design and manufacturing processes. Ability to learn and assimilate technology must have been raised by the government's initiatives on subsidizing and strengthening technological infrastructure over time (Pillai, 1979).

At the same time the learning process would be constrained if excessively the restrictive conditions were imposed on the use of imported technology by the government of the host country. Detailed information about restrictive clauses in agreements approved by the government of India not available. The ones approved upon the sixties invariably had such limiting clauses.

### *2.1. Promotion of indigenous technology*

In order to encourage the indigenously developed know-how and promote in-house R&D various policy measures have been adopted by the government. Mainly two types of policies affect R&D activity and its commercial exploitation. Firstly, those measures which are offered by the government in order to promote in-house R&D activity and the incentives offered by National Development Research Corporation (NRDC)[5] to firms and entrepreneurs to purchase locally developed technologies. Second, protection offered to indigenous know-how against foreign know-how by the licensing mechanisms.

The incentives offered to in-house R&D were quite wide. Complete income tax exemption was given to expenses incurred by a firm on R&D activities. Weighted deduction in taxes was also offered to expenses incurred by a private firm, which sponsored research in a national laboratory of CSIR[6] or a research association or an institution approved by the "prescribed authority" of the government in the field. A forty per cent deduction in computation of income and tax thereon is also made on income from royalty, technical fees etc. If the firm secures this income by providing know-how to foreign firm outside the country, the entire amount was deductible from income tax. A highly liberal policy of import of equipment, instruments and raw materials and spare parts needed for doing research by the research organizations recognized by the prescribed authority was also offered.

[5] NRDC is the key agency in the country mainly responsible for transferring research know-how to industry.

[6] CSIR is the biggest agency in the country responsible for industrial research. It has about forty national laboratories under its administrative control doing research in various disciplines like Physical Sciences, Chemical Sciences, Biological Sciences, Earth Sciences and Engineering Sciences. The CSIR is hundred percent funded by the government of India.

In 1976 this policy was further liberalized and private firms registered and recognized by the Department of Science and Technology (DST)[7] as having definite research schemes were allowed to import equipment, etc. needed for R&D work up to a value of Rs 100,000 without any import license. There were about 348 private firms and 20 public sector firms in 1976 which were recognized by DST as having facilities on in-house R&D expenses claimed by these firms, as R&D expenses in 1976 were around Rs 500 million (CSIR, 1979).

NRDC the organization mainly responsible for developing and marketing processes developed at CSIR laboratories also offers a number of services for purchase of know-how. Since the development of pilot plant prototype, demonstration plant, etc. add substantially to the total cost of developing the new technology and may constitute a crucial element in entrepreneurial decision to switch over to new technology, NRDC shares 50 percent of the cost incurred in these steps. Such a decision must be endorsed by the DST. Tax concessions were also offered to the entrepreneur on whatever expenses he incurred in these steps. The NRDC also offers a guarantee for performance of the new technology on a commercial scale and also helps with other services like obtaining imported equipment, materials and components and sometimes obtaining financial loans.

Among the indirect measures of protection offered to indigenous know-how, there were following types of regulation mechanisms: Industrial licensing, import and export stipulations differential laws of corporate taxation and control of foreign collaboration. (Subrahmaniam, 1972; Kidron, 1964 and Hazari, 1968) The general guidelines for control of foreign know-how and capital are specified in Industries (Development and Regulation) Act of 1951, the various Industrial Policy Resolutions and the policy statements of 1948, 1956, 1973 and 1977.

The emphasis and the focus of the control mechanism has shifted in different documents and these shifts have been interpreted differently in the studies made on the subject. Without going into the details of changing nature of the control mechanism we would present here its salient features.

Since the beginning the main thrust of the control of know-how on investment had been through the licensing device. All applications for foreign collaboration, and incorporation of foreign capital had to be submitted to the government and approved by the (inter-ministerial committee) Foreign Agreement Committee. In order to regulate the direction of agreement of technological change, the Foreign Investment Board of the Ministry of Industry had identified areas of industrial activity where foreign participation in know-how or capital or both are not needed. The Board also identified areas in which the country could be considered relatively self sufficient and no new technology was allowed to be imported. The government's licensing committee, however, had never interfered between the foreign collaborator and the local firm as a bargainer. It simply had the power of approving or rejecting the terms of the proposed collaboration. Such a mechanism had obviously its own limitations (Bhagwati and Desai, 1970).

But the main success of this device, it has been noted, that the government had been able to cut down the foreign costs of collaboration by regulating the terms of payments and royalties (NCAER, 1971).

Government has been successful in some cases in obtaining a progressive dilution of the foreign share holding, in deleting clauses banning exports, in preventing the use of brand

[7] DST is the government department responsible for funding of sponsored projects to various disciplines of science and technology at Universities and research institutions in the country. It also looks after the international cooperation in science and technology with other countries.



names and in insisting on the involvement of local design consultants. The government, in order to protect know-how had also put the representative of the CSIR in the licensing committee, which sanctioned the applications for collaboration. Differential laws of corporate taxation have also been stipulated for Indian and foreign firms as a measures of control of foreign know-how.

### *2.2. Problems with regard to technology transfer*

Problems of technology transfer can be discussed at two levels. First, at the laboratory level where right from the inception of the R&D project to its completion, secondly, when it is ready for commercial exploitation. Technology transfer is done through various transfer institutions like NRDC and TUD (Technology Utilization Division)[8]. Before that an assessment of the market demand and competition with the foreign technology is undertaken.

First, let us discuss the problems of technology transfer at the laboratory level. In a few CSIR laboratories efforts have been made to undertake studies on cost-benefit analysis, techno-economic feasibility, market demand and assessment of social needs for specific research programs[9]. The needs of the research and development are generally perceived by scientists on the basis of their knowledge in the area of research. Scientists are not sure about the economic feasibility of the inventions to be developed before the research is performed and actual bench scale results are obtained. Further, scientists are mostly concerned with the publication of the results of their research rather than with pursuing the planning of R&D activities beyond bench scale results for opening up opportunities for commercialization.

Moreover, a research project in which the whole range of technology transfer consists of detailed planning and complexity of management, which the scientists are reluctant to undertake. Some of them believe that planning is antithetical to scientific research itself. Furthermore, applied research is multi-disciplinary in nature requiring co-operation of a number of scientists and technicians.

In the operation of the project, the boundaries between research divisions are rarely transcended, inter-divisional co-operation is accepted in principle by the scientists yet it has not been achieved in practice[10]. The scientists' fears that a research project, involving high expenditure will not find favour from the authority. Finally the scientists do not have the business approach, they have not been trained for it. This is evident from the research results of the laboratories presented by them. These economic assessments have been rudimentary. Cost-benefit analysis has been worked out by manipulating figures, which are favourable to the research results. The investment figure for commercializing the results is underestimated while profits from production are overestimated (Tilak, 1972).

[8] Technology Utilization Division is one of the technical divisions at CSIR Headquarters, concerns with the formulation of rules and regulations for the transfer of know-how developed by CSIR laboratories.

[9] Before selecting R&D project it is approved by the Research Council of the laboratory consisting of eminent scientists and industrialists expert in the field. They generally examine the project from the technical point of view.

[10] Most of the CSIR laboratories have got the same organizational structure, To streamline the administrative control a laboratory is divided into different research divisions supported by the administrative staff. Big national laboratories like NCL, NPL, CDRI have got the strength of 1500-2000 staff with an annual budget of around Rs 100 million. According to Professor Nayudamma former Director General of CSIR, there is hardly any coordination among the scientist of different divisions. He says, "Scientists would like to work in water tight compartment".

This raises the expectations of the entrepreneurs to obtain high rate of return on their investment in the adoption of the indigenous know-how. It has been noticed that during the course of transfer of know-how, it was realized by many entrepreneurs that actual investment figures for setting up production were much higher than those contained in the estimates provided by the laboratory. There is little to blame the scientists for this. In the absence of availability of expert knowledge of the economic impact of indigenous research, application of techno-economic analysis to research projects and their results must be improved.

Interaction between laboratory and industry helps in the identification and selection of research projects which are connected with the problems of the industry. The research results obtained from such project have good chances of being commercialized. Impeded or intermittent communication kept the research results on the fringe of failure.

*2.2.1. Issues related to indigenous technology transfer from R&D laboratory to industry*

Technology transfer from R&D institutions to industry seems to be more complex and difficult in developing countries. In a developed country the industry has the necessary capabilities to assess the work done in R&D laboratories without much or any assistance from outside. The developed countries firms can conduct their own market surveys, organize the design and construction of the plant, training of the personnel, manufacture and ultimate sale of the product. This is not so in a developing country where the entrepreneur requires assistance from the stage of selection of a process or product until he sells it. He needs assistance for the preparation of the feasibility report for obtaining loans from financial institutions, design of the equipment, erection start up trouble shooting, training of personnel, maintenance and ultimate sale of the product. Often he needs special assistance, tax rebates to aid the sale of his product (Tilak, 1972).

The entrepreneurs want to have a technology with guaranteed performance. One of the best means of insuring transference of technology from indigenous research laboratories to industry is offering a) prototype of the product b) trying out of the processes/products on pilot plant scale and according to certain laid down specifications initially. It may be emphasized here that relatively more attention needs to be given to development work on pilot plants, prototypes demonstration units, making available feasibility report, cost estimates and market surveys.

Pilot plant work may even costs ten times more than the cost of the work done at the laboratory stage, but any hesitation or reservation in incurring this expenditure at the pilot plant/bench scale and demonstration stage could lead to severe-bottlenecks, even if the technology passed to genuine entrepreneur its commercial viability may eventually die. The work at the pilot plant level goes a long way to check premature or exaggerated claims of the R&D scientists and thus avoids later failures of the technology (Rajan, 1981).

There are problems in setting up pilot plants due to a) non-availability of finances, b) the time required to establish the plant is at least one year or sometimes more. By the time the pilot plant is ready the technology used is overtaken by new technologies developed somewhere else. Consequently, as much as possible, the R&D work should be completed at the laboratory stage. The availability of the feasibility reports, cost estimates and market surveys will fill the initial gaps and help to create confidence in the entrepreneur to convert the industrial research into a commercially viable unit.

The feasibility report prompts the prospective entrepreneur to know about the worthiness of the R&D work. It will determine whether or not the market exist for indigenous technology, raw materials, labour with necessary technical skill are available, infrastructure vital to



the project is at hand. The entrepreneur will also know the estimates of overall costs of plant and equipment etc. Most important is the fact that from the feasibility report the prospective entrepreneur is able to determine the expected income from the indigenous technology, which will help workout the profit margin. R&D laboratories can go a step further help the industry/entrepreneur by offering plant on turn-key basis with adequate performance guaranteed wherein the R&D personnel could be actively associated with the production operation even after commissioning the plant.

It is important to associate engineers (mechanical, electrical, electronic as the case may be) from industry with the R&D investigations at the early stages in the laboratories, so that difficulties of designing the plant, machinery and equipment, installation etc., could be avoided at the time of technology transfer. The indigenous technology developed in the laboratories will certainly be successful if the engineers from industry help scientists in the design of the plant and machinery in improving the quality of the product in response to market changes (Rajan, 1981).

Another problem of the technology transfer is the lack of confidence in the minds of Indian entrepreneurs in indigenous know-how. There is competition between indigenous technology in its infancy and foreign technology proved for several decades under well-known trademarks. Therefore, it is necessary to somehow instil the confidence in the Indian entrepreneurs about indigenous technology.

Technology transfer requires a long chain of activities such as assessment of market demand, availability of finance training of personnel...etc. Due consideration had not been given to provide a complete package of technology transfer to the adopters. Sometimes a technology is not utilized because the adopter is not able to obtain capital goods and raw materials licenses, or is unable to arrange foreign exchange etc.[11]

## 3. Impact of liberalization on technological change in India from 1991 onwards

A major objective of the economic reforms program initiated in India in 1991 is to make the country more attractive to the transnational corporations (TNCs), and induce them to invest more money in India. A basic premise of the new economic policy is that a larger inflow of foreign direct investment (FDI) is *per se* good for the country. In this section we are mainly concerned primarily with the question whether unregulated entry and expansion of TNCs is necessary for technological change in the country.

***3.1. Advantages for TNCs***

The policy changes since 1991 favourably influence the operations of the TNCs as discussed below:

(a) The restrictions on the spheres of operations of the TNCs have been drastically reduced. In the past new FDI had to be justified having regard to factors such as priority of industries, nature of technology, degree of exports etc. (Government of India, 1988).

[11] Over the last few years CSIR has made structural changes in the process of transfer of technology: first, it has adopted totally business approach towards selection of research projects, secondly it has established Business Promotion Groups at each laboratory to streamline the transfer of know-how.

The government used to announce illustrative list of industries where no foreign collaboration is considered necessary. These restrictions have been abolished. Now all the industries are open for entry of foreign investors, though for those industries not mentioned in Appendix 1, government permission is still necessary. Moreover, the policy of automatic approval in Appendix 1 industries makes the policy transparent and is expected to reduce the bureaucratic impediments associated with discretionary policies of the past.

The sphere of operation of the existing foreign companies will be much larger due to the following reasons:

(1) FERA companies are no longer required to restrict their activities to Appendix 1 industries or to predominantly export oriented activities.

(2) The industrial policy of 1991 has drastically reduced the number of industries reserved for the public sector. The list has been further reduced in March 1993. Now only six industries viz., defence products, atomic energy, coal and lignite, mineral oils, railway transport and minerals specified in the schedule to Atomic Energy order 1953 are reserved for the public sector (Government of India, 1994). Thus the TNCs (as well as the Indian private companies) are now permitted to invest in iron and steel, mining of iron ore, heavy electrical plant, telephone and telephone cables generation and distribution of electricity etc., which were previously reserved for the public sector.

(3) The protection provided to small-scale firms being reduced. The government has decided to slash the list of items reserved for the small-scale sector. Garments, e.g. has already been de-reserved. The large firms are now allowed to produce the items reserved for the small scale sector provided they export 75 per cent of the output it has been reported that the government is planning to induce the export obligation to 50 per cent[12]. The small scale sector also used to be protected indirectly under the policy of excise tax exemption. Within the withdrawal of such exemptions in the Union Budget of 1994–1995, the advantages enjoyed by the small manufacturers will be eliminated in a large number of industries, e.g. shoes, bar soaps etc.[13]

(4) The industrial policy of 1991 has abolished industrial license except for a short list of industries related to security and strategic concerns, hazardous chemicals, few items of elitist consumption, etc. Licensing has been further liberalized with motor cars, white goods (refrigerators, washing machines, microwave ovens, air-conditions etc.) and almost all the bulk drugs and their formulations taken off the list of industries for which licensing is still required (Government of India, 1994 and Government of India 1995).

(5) The restrictions imposed by Monopolies and Restrictive Trade Practices (MRTP) Act[14] large firms expansion merger amalgamation and take-over etc. have been abolished. Such enlargement of areas of operations of existing firms also acts as an incentive for new firms. A new TNC is required to participate in the Appendix industries to be eligible for automatic 51 per cent foreign equity, but once the company is set up, the TNC can expand and diversify as explained above.

(b) Under the previous policy the foreign companies were debarred from using their brand names fully unless the sales were for essential drugs and pesticides. It is believed that

[12] Business World (BW). 1994. February 23 — March 8.

[13] BW. 1994. March 23 — April 5.

[14] MRTP Act introduced in 1969 it says that the industrial groups with assets of Rs. 200 million and above would be allowed to undertake activity only in specific group of industries.



the free use of brand names now would enhance the market power and hence the growth of TNCs in India.

(c) Left to themselves the TNCs naturally would decide the nature of their operation in a particular country with reference to their objectives of global profit maximization. The trade restrictions on the TNCs in the form of a local content or export performance requirements as we had in India to some extent, often conflicted with such global objectives. Now the TNCs in India are no longer required to export in order to enter, grow or have higher foreign equity. Similarly with the abolition of the Phased Manufacturing Program (PMP)[15] the TNCs are now free to decide whether they will use imported or local material.

(d) Another advantage claimed for the TNCs is the increase in the permissible extent of foreign equity from 40 percent to 51 per cent. A new TNC can automatically have 51 per cent foreign equity (and an existing one can increase it to 51 per cent provided they participate in Appendix industries.

### *3.2. Response of TNCs*

The TNCs have reacted favourably to the new economic policy to enter and to grow in India. Gross inflow of FDI have gone up from Rs 5.3 billion in 1991 to Rs 38.9 billion in 1992, Rs 88.6 billion in 1993 and Rs 141.9 billion in 1994[16].

The entire amounts of FDI inflows are not being used for Greenfields projects. As discussed below, the TNCs are buying up Indian companies increasing their stake in existing companies, etc. Several steps have been initiated which will enhance the managerial control and the market power of the TNCs at the cost of Indian entrepreneurs.

### *3.3. Mergers and acquisitions*

With the virtual abolition of FERA[17] and the monopolies part of MRTP, etc. there has been a sharp rise in the numbers of mergers and takeovers of companies. A few TNCs have sold out their companies/divisions to Indian-owned companies (Roy, 1994). For example, the textile tycoon Ajay Piramal has bought out the Swiss pharmaceutical TNC Roche's 74 per cent stake in its subsidiary in India[18]. Similarly the Indian groups of Reliance and GP Goenka have taken over the fertilizer and polyester divisions respectively of the British TNT, ICI (Roy, 1994). Tata Chemicals plans to acquire the phosphoric acid plant of Occcidental Chemical Co in Florida[19]. But what has really attracted attention is that a number of dominant indigenous enterprises, which have been competing against TNCs in their respective fields, are succumbing to TNCs. As a result, the structure of a number of industries is changing radically.

For failing to comply with the provision of FERA Coca Cola departed from India in 1977. This paved the way for the growth and domination of the soft drinks industry by Indian firms. About a decade later, the government allowed Pepsi. But the government imposed

[15] PMP was part of Technology Policy Statement 1983, which suggests that every industry importing technology has to undergo through the process of assimilation and adaptation by involving a research institution.

[16] Economic and Political Weekly. 1995. March 11. P. 475.

[17] FERA (Foreign Exchange and Regulation Act) introduced in 1973 which restricts the industrial activities of the companies having more than 40 per cent foreign equity to the same group of industries as the MRTP houses.

[18] Business India (BI). 1993. November 22 — December 5.

[19] Economic Times (ET). 1994. April 7.

a number of conditions e.g. an export obligation. The government did not allow unrestricted use of the brand name: Pepsi had to agree with the hybrid name: Lehar Pepsi, Pepsi was not allowed to own majority share. The equity of the company in India was held 44.35 per cent each by Pepsi and Voltas and 11.3 per cent by Punjab Agro Industries Corporation[20]. Pepsi could not dislodge Parle as the largest firm. Parle continued to be the market leader with about 60 per cent market share.

The recent policy changes and the re-entry of Coca Cola in 1993 however have changed the industry to almost 100 % TNC controlled. Coca Cola has ousted the market leader Parle, Ramesh Chauhan, the chief of Parle has sold out the successful brands of Parle--Thumps up, Limca, Citra Gold Spot and Maza — to Coca Cola for an amount reported to be $ 60 million Parle now has effectively been reduced to a bottler for Coca Cola[21].

In the light of the new economic policy and also to ensure quality of treatment between Coca Cola and Pepsi, the government has withdrawn all the conditions previously imposed on Pepsi. As a result, Pepsi has not only bought the stakes of Voltas but also plans to buy out the remaining shares held by Punjab Agro so that it will be a 100 per cent subsidiary. Pepsi has acquired another Indian soft drinks company, Duke, which has a strong presence in the Bombay region. Its market share of 37 per cent in Bombay is larger than that of Pepsi's though less than that of Parle's (45 per cent)[22].

Both Parle and Duke hold the government policy responsible for the demise of indigenous enterprise in the industry. The century old concern of Duke initially did not respond to the feelers from the TNCs to come to an understanding. But in view of the fact that the TNCs are spending massive amounts in the industry and are willing to withstand losses for several years to establish themselves. Duke decided to concede. As the 80 year old chief of Duke said, "There would be something wrong in my head if I didn't see the writing on the wall. I have been in the business for 59 years and with the money the MNCs are spending, I simply can't do well"[23]. Again as Ramesh Chauhan pointed out in an interview, "Pepsi was given permission, the government's overall policy was not to open floodgates for multinationals. I knew that I would be able to stop its entry. Today it's a very different situation — It made good business sense to realise the limits of one's potential and bow out — Indian entrepreneurship can develop only with the government support. Otherwise we will be reduced to just the bunch of traders working on commission"[24].

Similar apprehensions are being expressed in other industries. Thus the chief executive of Harbans Lal Malhotra and Sons (HML) pointed out that "It would be foolish to sit idle and watch a slow but steady decline of our share of the market (69 per cent) in the face of competition from other superior makers"[25]. HML has been for a long time the market leader in the shaving products industry where the entry of TNCs was regulated. Gillette, the global market leader, operates in India through Indian Shaving Products Ltd. the former was not allowed to own majority shares. It is only recently that Gillette has increased its stake to 51 per cent. Like Pepsi Gillette could not dislodge the market leader. It was only partially successful in India with a 10 per cent market share. However, under the new economic

[20] ET. 1993. August 24.
[21] ET. 1994. September 24.
[22] ET. 1994. April 11; BW. 1994. March 9–22; ET. 1994. May 27.
[23] BW. 1994. March 9–22.
[24] ET. 1994. April 19.
[25] Business Standard (BS). 1994. December 29.



policy, Gillette is now trying to buy out its competitors by using massive financial power. The deal has not yet been struck apparently due to differences among the three brothers who own HML, Gillette, however, taken another Indian company, Wiltech India[26].

In the ice-cream industry, an Indian company, Kwality has been the market leader with about 50 per cent share. Brook Bond Lipton India (BBLL), a Unilever group company which has recently set up a plant to manufacture frozen desserts has taken over the marketing networks of Kwality in the northern, western and southern regions of the country. Kwality will continue to own the manufacturing facilities, but these will be used exclusively for BBLI. One of the families controlling the eastern region operations of Kwality is still reluctant and hence is not part of the deal[27]. BBLL has also acquired the ice-cream division of another Indian company, Milk food which is a part of Jagatjit group companies[28]. It has been reported that another TNC Nestle has also started negotiations for tie up with the remaining important Indian companies like Vadila Arun and Joy to market ice-creams[29].

Soaps and detergent is another industry where indigenous enterprise like Godrej, Tata Oil Mills, Nirma, etc., have successfully competed against the TNCs such as Hindustan Levers and Proctor and Gamble. But the alliances and mergers allowed under the new environment have significantly enhanced the market power of the TNCs Tatas have decided to relinquish control in Tata Oil Mills and merge it with Hindustan Lever[30]. The merger scheme in fact envisaged issue of shares at a discount price to Unilever to enable it to have 51 per cent shareholding in the merged company. RBI however, has objected to the issue of shares at a discount price. Another TNC, Proctor and Gamble have practically bought off its competitor Godrej Soaps. The two companies have decided to float a new company where the former will have the controlling stake of 51 per cent and the latter the minority one of 49 per cent. While Godrej will make available its production capacities and the distribution network. Proctor and Gamble will provide international technology and brands[31]. Godrej has transferred the marketing, distribution and sales rights of all its toilet soap in the market which will compete with the brands of the new company controlled by Proctor and Gamble, justifying the deal, the managing director of Godrej Soaps said that to compete against the TNCs, the company requires financial and marketing muscle which it does not possess[32].

Bajaj Electricals, a dominant player in the home appliances market has decided to withdraw its products gradually from the market. This is an offshoot of the formation of a joint venture company between Bajaj and US tools and appliances giant Black and Decker. Bajaj will henceforth market the products manufactured by the new company[33]. Another joint venture announced between the two companies having business in the same field is between General Electric (owns 40 per cent equity) and Godrej and Boyce (60 per cent). The new company will take over the latter's refrigeration division G and B is now the market leader in refrigerators with a share of 45 per cent. The company will also diversify into compressors, washing machines, dishwashers, microwave ovens and other household appliances[34].

[26] ET. 1995. March 17.
[27] BS. 1994. September 14; BS. 1994. September 30; BW. 1994. January 25 — February 7.
[28] ET. 1995.April 7.
[29] ET. 1995.April 21.
[30] ET. 1993. March 11.
[31] ET. 1992.August 22.
[32] BI. 1993. April 26 — May 9. P. 57–58.
[33] BW. 1994. December 14–27.
[34] BI. 1992. May 25 — June 7; BI. 1993. April 26 — May 9.

The government's indifference to that status of the indigenous firms has surprised a number of experts. Commenting on the sell out of Parle to Coca Cola, Michael Porter, who studied competitiveness in different countries, has pointed out that "Few countries in the world would permit their dominant national player to be brought over by a multinational"[35]. Japanese TNCs have played an important role in Japan's economic prosperity, Saboro Okita, the veteran development economist who had direct experience in economic policy making in Japan in 1960s has advised against an overall opening up Indian industry to foreign investments. Giving the example of automobile industry in Japan, he argued that if Japan had opened its economy 20 or 30 years ago, then the Toyota and Nissans might not have existed today[36].

Some of the Indian industrialists e.g. Hari Shankar Singhania, who is a prominent member of the Bombay Club mentioned earlier, has complained about the pace of reforms. He pointed out that for industrial development, the basic role will have to be played by the indigenous sector. And the government encourages indigenous firms to grow before fully liberalizing foreign investments[37]. It however appears from demands put forward by the Bombay club, that these industrialists in general are more concerned about getting certain financial facilities to enhance their equity holdings and to prevent takeover. But undisputed control over their firms is not enough to tackle the TNCs (Ghosh, 1993). What is also important is government's support for the indigenous firms to grow *vis-a-vis* TNCs.

### *3.4. Attitude of foreign investors*

The statements of industrialists and executives from abroad, who have been visiting India lately, convey the impression that they are more interested in the domestic market than in exports. A high level 50 member strong Japanese business team visited India in January 1992. The leader of the delegation pointed out that the large domestic market in India is a major attraction. To facilitate further Japanese investments, the team in fact requested the government among others not to insist on exports to pay for their dividends repatriation[38]. Addressing the Indo-US Chamber of Commerce, a representative of a large US firm said in January that the restriction on dividend repatriation subject to export earnings has raised doubts about whether India would allow reasonable access to the domestic market. This has made the TNCs sceptical about investing in India[39].

The president of the Federation of German Industry, who led a business delegation to India, said that there are two major motivations for German firms to invest in India (1) domestic market (2) low cost of production base for exports mainly to the Far East. He did not clarify whether both are equally important and if not which is more important. But significantly enough he also asked for the withdrawal of the export obligations.

The conditions of balancing dividend repatriation with export earnings were actually withdrawn in response to the complaints made by the foreign investors[40]. The Press Note which announced the withdrawal of the dividend balancing conditions in fact specifically mentions that this is being done to further stimulate foreign goods into the country (Government of India 1993b).

[35] BW. 1994. October 5–18.
[36] ET. 1992. February 4.
[37] ET. 1993. November 9.
[38] Times of India (TI). New Delhi. 1992. January 28.
[39] Indian Express (IE). New Delhi. 1992. January 16.
[40] ET. 1992. June 20.



The former chief of the Proctor and Gamble operations in India who has now joined the headquarters in the US said that India's biggest advantage is the large domestic market. The attitude that TNCs would come to India only to export and not to take advantage of the domestic market will not help[41]. A survey was conducted in the US to ascertain the prospects of US FDI in India compared to that in other Asian countries. The survey found that US investors are primarily interested in India for domestic production rather than for exports. Among the 23 factors identified, the most important factor influencing investment in India was found to be the size of the domestic market. The motivation of "exports to the third countries" and exports back to USA is ranked 15th and 20th respectively in descending order of importance.

### *3.5. Prospects of Export-oriented FDI in India*

International production of TNCs actually has traditionally been organized primarily for the domestic markets of the host countries. Export-oriented investments were mainly restricted to natural resources. Studies on the determinants of FDI found that factors such as market size, trade restrictions are much more important than cost factors in determining such domestic market-oriented investments (UNCTAD, 1992).

An important change in the behaviour of TNCs over the last thirty years has been the increase in export-oriented investments in manufacturing by the TNCs abroad to take advantage of certain favourable conditions in the host countries e.g. lower cost of labour (UNCTC, 1985; UNCTC, 1992). With the intensification of international competition, the TNCs become more cost-conscious. The fall in trade barriers and communication technologies have made it possible for them to transfer a part of their activities to cheaper locations. Such export-oriented investments, however, were restricted to specified products/processes and these were located in selected countries in Asia and Latin America (United Nations, 1992; UNCTAD, 1993).

India was not one of the major destinations for these investments. As discussed in the previous section, the response of the TNCs as of now does not reflect a sharp break from the past. But it may be argued that the period since 1991 is too short to observe such a shift. If we take a longer term perspective, then under the new economic regime, is there a possibility of a significant spurt in manufacturing exports by the TNCs from India? This will depend on the growth of the relocation of production by TNCs in the third world countries and the share of this growth which India can manage for herself.

So far the size and the growth of international production by TNCs in the third world countries are concerned, the future trend is not very clear.

On the one hand. The *World Investment Report 1993* speaks of the emergence of an integrated global system of production. In the past the TNCs transferred particular activities to locations with cost advantages. They are now slowly moving to a system where all the activities of the firm are potential candidates for being undertaken in different locations depending on the respective advantages. Hence the report predicts an upsurge in the volume of international production (UNCTAD, 1993).

But on the other hand it is not very clear to what extent the third world countries will be able to take advantage of such increased internationalization of production as and when it takes place. The traditional advantage of the third world countries is the low cost of labour. A survey conducted by the International Finance Corporation on US TNCs

[41] ET. 1991. August 22.

found that new manufacturing technologies have made labour cost much less important than what it was before and hence the third world countries have become less important as export platforms to serve the developed country markets (Miller, 1993). A number of TNCs in consumer electronics (e.g. Philips) and computer (e.g. IBM, Apple) have already initiated steps to automate their plants at home and shift production from third world countries (UNCTC, 1988).

The International Finance Corporation study has also reported that radical organizational changes are being undertaken in TNCs which have negative implications for plant locations in the third world countries. Companies are trying to reduce costs through low inventories and quickness of response. The trend is to locate plants close to the customers. As a result the number of supplier's factories is increasing the average plant size is decreasing (Miller, 1993).

Thus export oriented investments by the TNCs may not increase at the same rate as in the past. Moreover, whatever may be the volume of such investments; the share of India will crucially depend on the advantages she offers compared to her competing countries. To attract FDI for export what is important is not whether the situation is better than that in the past but whether it is better than what the competing countries offer.

It appears from the demands put forward and the comments made by some of the foreign investors as referred below that India compare not so favourably with the competing countries. In terms of (1) infrastructure (2) control over labour (3) priority accorded to FDI etc.

A report of the Far Eastern Economic Review (FEER) sums up the general perception of foreign investors about India as follows.

The Indian business climate is not yet as hospitable as other locations for scarce capital. Wages rates are low, but so is productivity. Labour is highly specialized and powerful trade unions are reluctant to abandon traditional inefficient practices.

Infrastructure is already inadequate: for example, like all industries with continuous process, Du Pont is faced with having to provide 100 per cent power back up for its Goa plant. The country has only 5.5 million telephones lines for 850 million people.

Various local levies slow down distribution of materials and products; a truck with a valuable cargo may have to queue for two to three days at a state or city boundary, to pay octroi of a few US dollars[42].

To facilitate investment from Japan, a business team from that country has specifically requested the government among other things, for an early formulation of exit policy and more investments in infrastructure such as power and telecommunication services[43]. The leader of another Japanese business delegation reiterated that Japanese investments in India are unlikely to increase substantially unless an exit policy is formulated and unions are prevented from interfering with the working environment[44]. The US ambassador to India said that "Expansion in India's power sector will help attract higher levels of foreign investment. A major concern of foreign investors is the lack of a reliable power infrastructure relative to other opportunities in Asia"[45]. The government has taken a number of steps to improve the infrastructure facilities. But for obvious political reasons governments in the exit policy front have been slower than what has been desired in certain quarters.

[42] Far Eastern Economic Review (FEER). 1992. February 20.

[43] TI. 1992. January 29.

[44] BS. 1993. November 27.

[45] BI. 1992. July 6–19.



A conference of leading industrialists, official from World Bank Asian Development Bank, etc. organized by Foreign Investment Advisory Service (a joint facility of the International Finance Corporation and the Multilateral Investment Guarantee Agency) in Washington concluded that India has been unable to attract enough FDI due to "restrictive policies and bureaucratic red tape". The participants felt that a more welcome attitude to FDI is needed in India[46].

What often matters is not what has been indicated in official policy statements. A study sponsored by ministry of industry of the government of India, reveal that right now the foreign investment policies in India are much more open than most other Asian countries. In China, Indonesia, Malaysia and Taiwan, prior approval of the government is required for foreign investment projects. India in fact is similar to South Korea and Thailand where automatic approval is given for some industries, but prior permission is required for the rest. Only in Singapore no approval is required.

## 4. Korean policies and firm strategies: target oriented export model

The basic component of the foreign investment policy followed by South Korea e.g. during the formative years of her industrialization (1960s and 1970s) were: (1) to promote foreign investment in export oriented activities (2) to simultaneously develop independent channels of exports (3) to strictly regulate foreign investment for the domestic market by preventing the entry of TNCs in area where Korean enterprises are present and by insisting on local content requirements, etc. (4) to encourage foreign loans rather than foreign direct investment; joint ventures rather than 100% subsidiaries and direct import of technology through TNCs and (5) to have a strategic program to promote indigenous technology and enterprise by regulating the TNCs and encouraging indigenous efforts (Mason et al., 1980; Amsden, 1989; Haggard and Moon, 1983).

The electronics sector in South Korea provides a good example of such a strategic intervention on the part of the government. Initially the activities in the electronics sector were primarily restricted to assembling of black and white TVs. In the late 1970s as the part of the Fourth Five Year Plan (1977–1981), a conscious attempt was made to develop the sector beyond assembling. Several items e.g., semiconductor, computers etc., were selected for import substitution and export promotion. Among the steps taken by the government were: establishing a research institute for import of technology and further development: protecting the domestic market against imports and restricting the entry of TNCs (Amsden, 1989).

Thus South Korea did not provide unrestricted entry and freedom to the TNCs. Their operations were consciously regulated to minimize the negative features and induce/force them to contribute to the growth of the economy. The assessment of the policy planners of Korea appears to have been that the TNCs can contribute by providing (1) technology and (2) market access for exports. The strategy was to regulate the TNCs to ensure such contribution while simultaneously developing Korean technology and enterprise.

Korea's export performance in the electronics industry has been truly remarkable. From the meagre of $89 million in 1971, Korean electronics exports grew to $20.683 billion in 1992, an increase by a factor of 232. An industry that barely existed more than 25 years ago has been able to transform itself into a credible international competitor. Specially since the

[46] FEER. 1992. August 10.

mid 1980s, Korean electronics firms have penetrated a number of important international market segments. They are the second largest supplier, behind Japanese firms, in both the United States and Europe for a variety of consumer devices, ranging from radio equipment to CTVs, VCRs and microwave oven. Korean firms also excel as leading suppliers of PC monitors. Their meteoric rise in DRAMs (Dynamic Random Access Memories) is notorious, the three main Korean producers, Samsung Electronics (SE) Hyundai Electronics (HEI) and Goldstar succeeded in eroding the once overwhelming dominance of Japanese producers. Between 1988 and 1992, Korea's market share increased from 7.5 % to 17.7 % in US, from 7.8 % to 18.1 % in Europe and 23.6 % to 33.7 % in East Asia (exclusive of Japan)[47]. Semiconductor exports are now the largest item of Korea's electronics exports from an estimated $7.8 billion in 1993, it has increased to $11 billion in 1994. Since the seventies its export grew considerably faster than those of Korea's other industrial sectors. During the seventies electronics exports experienced a compound average annual growth rate (CAAGR) of over 43 %, while CAAGR for all manufactured exports was 35.6 %. Korea's electronics export passed the threshold of $2 billion around 1980 and continued to grow very fast at a very fast pace though most of 1980s, well above the growth for Korea's overall manufactured exports. This rapid growth of exports continued even after 1987 when rising wages and various appreciations of the won led to an erosion of Korea's traditional labour advantage. From $ 2.2 billion in 1981, electronics exports experienced a nearly eightfold increase to $17.2 billion in 1990 resulting in a CAAGR approximately 22% (much higher than the slightly less than 17% CAAGR for all manufactured exports). Due to this rapid growth in exports in 1988 the electronics industry became the country's biggest export item, overtaking for the first time the textile industry, the traditional export sector.

This section analyses how government policies and firm strategies have shaped the particular pattern of development of Korean industry. Foreign firms originally played a catalytic role in the launching of Korea's electronics exports. How and why the Korean government and the Chaebol[48] began in the mid 1970s to play an increasingly important role. In order to highlight some peculiar features of the government business interaction and their impact on Korean electronics industry. In earlier developments in Japan, which for all practical purposes, have guided Korea's policy interventions and from strategies as an implicit role model. Given its overwhelming concern with a rapid expansion of production capacities and market share, Korea copied a number of Japanese policy instruments. Three of them are of particular importance (1) Sophisticated mixture of import restrictions and export promotion (2); An emphasis on aggressive absorption of foreign technology while at the same time restricting inward foreign investment; and (3) A focus on creating national championship through sectoral targeting.

Such similarities, however should not be exaggerated, and important differences continues to exist between both the countries especially in terms of the industry structure and the resulting competitive strategies of firms. These differences reflect the idiosyncrasies in the development of institutions and organization in both the countries as well as that Japan has started decades earlier than Korea with its expansion into international electronics markets, and thus had to confront less demanding and complex competitive requirements. In the case of Korea the very same feature of government policies and firm strategies and of the resulting industry structure that until the late 1980s were conducive for the rapid expansion

[47] Figures provided by Dataquest (American magazine). 1993. September.

[48] Chaebol is conglomerate of big firms of Korea like Samsung, Goldstar, Hyundai and Daewoo.



of Korea's electronics exports now have become important constraints for attempts to sustain Korea's exports performance through an upgrading of its technological capabilities.

We have seen that Korea's electronics exports only started to take off when Korea became a final assembly export platform for a handful of US semiconductor firms. This was made possible by the willingness of the Korean government already during the 1960s to shift to the export promotion. Combined with tough labour legislation's and the ruthless suppression of labour conflicts, the Electronics Industry Promotion of Law of 1969, which made electronics a strategic export industry and the opening of the Mason Free Export Zone in 1970 contributed to the positive foreign investment climate in this industry. The main attractions for foreign electronics companies were Korea's cheap female labour and incredibly long annual work hours, together with policies favourable to the promotion of export manufacturing. At this stage technological capabilities were of minor importance and remained restricted to a few basic assembly tasks.

In 1968, foreign (predominantly US) companies were responsible for 71% of Korea's electronics exports and practically all its exports of integrated circuits and transistors originated from newly established subsidiaries of US firms[49]. Japanese firms for political reasons were late to invest in offshore chips assembly in Korea, Sanyo's joint venture, Korea Tokyo Silicon Company, Ltd., established in 1972, became the largest assembly line. In that year foreign firms, of which there were eight, accounted for about a third of Korea's electronics production and 55 per cent of its exports. It would be 1980 before their share in export fell below 40 per cent (Bloom, 1992). In short until the late 1970s, Korea's exports growth in electronics was led by foreign firms and based on simple, labor intensive assembly technology borrowed from abroad.

Initially at least, the electronics industry diverges from the common perception that Foreign Direct Investment (FDI) played only a minor role in the development of the Korean model (Haggard, 1990). By opening up export channels for assembled chips and from simple consumer devices FDI did indeed play an important catalytic role during the critical early phase of the development of Korean electronics industry. One techniques, which, not necessarily "best practice" certainly contributed to a gradual erosion of the traditional highly authoritarian Korean management practices[50] and their inherent rigidities and inefficiencies. Cost-cutting and need to comply to some minimum international quality standards without any doubt gave rise to some limited indirect learning effects related to the formation of production and investment capabilities. Yet as we will see in the next section, this was about all that foreign investment was willing to contribute during this early stage. For that to change, Korea needed systematic and well-coordinated government policies to promote the development of Korean firms.

### *4.1. Some basic features of Korean model*

While Korea's export growth in electronics originally was led by foreign firms, the Korean government and the chaebol played an increasingly important role, especially since

[49] In 1968, four United States companies dominated Korea's chip assembly industry: Motorola, Signetics Fairchild Semiconductor and Komy Semiconductor Corporation, a United States joint venture which established the first transistor assembly line in 1965. Data taken from Dataquest Inc. report "Assembly industry — South Korea", March 1987.

[50] For two historical case studies of these changes in the Samsung Group, see Janelli, Roger and Yim Dawnhee [1993] and Lee Jin-joo [1991].

the mid-1970s. This shift in the center of gravity among the social carriers responsible for the development of Korea's electronics industry was due to number of locations in Philippines and Malaysia and gradually shifted most of their assembly activities to these two countries. Confronted with an increasing cost of capital, most of these companies were keen to reduce their equity involvement and began to shift too much looser firms of contract assembly, sub-contracting and OEM arrangements. In the case of Korea this gave rise to the development of Anam industrial, which, through its US based marketing subsidiary Amkor today has become the world's largest independent SC contractor assembler. Japanese firms in turn choose a somewhat different route, and this applies both to chip assembly and to their activities in other electronics components. In contrast to US firms reliance on foot-loose of offshore assembly, most Japanese firms concentrated on factory automation at home and gradually withdrew from offshore assembly activities both in Korea and Taiwan.

Parallel to this process of gradual withdrawal of foreign firms, there have also been push factors resulting from the increasingly demanding requirements imposed by the Korean government on foreign firms to contribute local value added and to increase the transfer of technology. Japanese firms in particular were extremely reluctant to open their closed international production networks and were concerned about a "boomering effect" through involuntary technology linkages. At the same time, rising competition from the increasing powerful chaebol added further pressure on foreign firms. Confronted with the alternatives to either upgrade their existing investment beyond the stage of assembly elsewhere. Within East-Asia, despite serious attempts by various Korean governments to bring foreign investment back into the country as a vehicle for accelerated technology diffusion. In 1992, for instance, Korea experienced an overall decline of inward FDI of 30 per cent to a low of $895 million since 1988, Korea has failed to appear on the list of the preferred ten foreign investment locations for both US and Japanese electronics firms.

For quite sometime there was no fundamental conflict between the interests of the Korean government and chaebol. Interaction between these two actors was driven by a common purpose — the rapid expansion of production capacity and international market share. As a result we find a fairly consistent pattern of latecomer industrialization which is characterize by the following features:

— A strong emphasis on export expansion based on imported technology.

— An early integration of Korean production into the international sourcing networks of electronics firms and mass merchandisers from the United States, Japan and Europe.

— An important role of government policies and regulations which in addition to providing essential externalities (especially a well trained industrial labor force), were focused on a judicious combination of export promotion and import restrictions sectoral targeting and the channeling of the investment funds to a select group of national champions.

— And finally, an industry structure which is characterized by a very high degree of concentration, due to the dominance of the chaebol and their privileged relationship with the government, but which at the same time is shaped by an intense competition among the leading chaebol. In the essence, the Korean electronics industry today is characterized by a tight oligopoly as defined by Bain (1956, 1959 and 1966). Others have stressed the advantages of such an industry structure for late comer industrialization[51].

[51] See the study of Martin Bloom [1992] on the Korean electronics industry. For more general argument, see Amsden [1989].



***4.2. Governments policies and regulations***

Policy interventions by the Korean government have played an important role in shaping the competitive strength and strategies of Korean electronics firms. Most debates narrowly focused on the macro-economic policies and the trade and exchange rate regime (OECD, 1992). By reducing market distortions, such policies are expected to generate quasi automatically an investment climate where "private domestic investment and rapid growing human capital — [can act as] — the principal engine of growth (Bell and Pavitt, 1993)."

One can't subscribe to such free market neo-liberalisation and will consider a much wider range of policy instruments and institutions. But this is not to deny the importance of macro-economic stability. Even though Korea borrowed heavily on international capital markets during the 1970s to offset the savings-investment gap caused by the government's policy of controlled interest rates and subsidized credits, it has not faced the debt crisis of the large Latin American borrowers.

Probably this is due to Korea's unremitting emphasis, shared both by the government and the chaebol, that would eventually help reduce its foreign debt burden. As for the trade and exchange rate policies, there is a strong evidence that, by and large, Korea has been able to establish a rough incentive neutrality between imports and exports rather than a strong bias in favor of the latter. Korea has frequently used selective "infant industry" as a part of its industrialization strategy, especially in the electronics industry. But import protection was mostly coupled with offsetting incentives for export sale, with the result that overall neutrality was roughly maintained the import protection enabled producers in a new industrial sector like electronics to exploit learning economies, while the export incentives provided the opportunity to reap scale economies not available in the domestic market.

This selective and at the same time synchronous approach to import substitution and export promotion as alternative development strategy has been greatly exaggerated as has the distinction between minimal government and a more direct and intensive role for the government. The objective is to understand the economy and society well enough to be able to identify where and how protection is effective and where and how division of labor should be arranged between the public and private sector in order to produce growth of well being — The notion that an economy (and indeed a society) that is in the same ways open is an idea that merits a great deal of attention.

Two arguments can be made for an active role of industrial and technology policies in the development of Korean electronics industry. First, the by now widely accepted "late industrialization" argument which shows that, without complementary government interventions, developing countries would have limited chance to begin a sustained industrialization process. Second industrial and technology policies have played a prominent role in the development of the electronics industry nearly everywhere. Due to high entry barriers and the importance of scale and external economies in the electronics industry government interventions are required to provide externalities and assist firms in their attempts to hurdle entry barriers. There is now a rich literature, which documents how critical such policies were in the United States, Europe and in Japan. There thus nothing unusual in the fact that Korea relied heavily on a variety of industrial and technology policies to promote its domestic electronics industry. The debatable issues are not that such policies have been pursued but what have been their main objectives and to what degree and at what cost have these been implemented. The most important policies used by the Korean government between 1967-1987 to promote electronics industry cover the whole spectrum of government interventions that have been used in OECD countries for the development of this industry.

Probably the most important feature of these policies is how closely they followed the Japanese pattern of policy interventions. Since the enactment in 1969 of the law of promoting the electronics industry, the Korean government has been providing various types of support to the electronics industry. The crucial importance of financial support has been widely recognized in the existing literature (Amsden, 1989 and Haggard, 1990). In addition the government has developed a rich arsenal of complementary legal supports that were meant to increase the effectiveness of the 1969 electronics industry promotion law. These complementary laws include a law for the promotion of national investment, a basic law for preferential tax treatment, a special law granting the return on tariff collection for raw materials used for exports, and law for promotion of SMEs.

Sectoral and product specific targeting also played an important role from the outset. While originally somewhat crude and unrealising targeting became more sophisticated during the four five year plan (1977-1981). In this plan, the following products were identified as "strategic development products" for the electronics industry:

— radios, black and white television sets tape recorders color TV sets, VCRs, digital watches and microwave ovens — for the consumer electronics sector;

— minicomputers, computer peripherals (especially monitors) electronics telephone exchange equipment, lasers, and electronics measurement equipment — for the industrial electronics sector;

— memory chips and connectors — for the electronics component sector.

Our analysis in the previous section of the product composition of Korean electronics exports shows that such policies have been roughly highly successful both for consumer electronics and for components, at least in terms of pace of expansion of production capacity and market share expansion. Yet no comparable progress could be detected in the trade statistics for industrial electronics. This failure in industrial electronics constitute an important flaw to the otherwise excellent reputation of Korean-style industrial policy that needs to be explained. The types of the policies that were conducive for developing mass-production capabilities for consumer goods and components may not necessarily have been the most appropriate ones for developing a sound industrial electronics sector.

One certainly cannot argue that the government neglected the development of industrial electronics. Ever since Park Chung Hee's ambitious plans to move beyond labor intensive assembly and to develop a broad base during the 1970s, Korea's industrial planners were convinced that in order to sustain their earlier success in chip assembly and low-end consumer electronics, industrial electronics would have to be substantially strengthen. In 1981, the electronics industry promotion law was revised to emphasize the production of electronics goods for industrial purposes rather than for household appliances and also to encourage the development of more advanced technology.

By the mid 1980s, the prevailing feeling was that Korea had gathered sufficient strength to try to upgrade its electronics industry and to transform it into a truly high-tech strategic industry that would push forward the modernization of its economy. It was also assumed that for the new stage in its industrial transformation Korea could rely again on its proven winning formula: the tight cooperation between the state and chaebol[52]. These expectations were centered on two main areas: the development of public switching systems and a development of a Korean computer industry with a focus on micro and mini-computers.

[52] Some interesting examples of these debates can be found in the special issue of *Electronics Korea*, August 1988, entitled "Painful Steps Towards Maturity -Industry After 30 years."



As for Korea's attempt to develop an internationally competitive computer industry, the results appeared to be fairly positive until around 1987. Both for 8 bit and 16 bit PC desk top machines, Korean firms experienced a rapid increase of OEM exports. And OEM exports grew even faster for computer terminals and monitors. Competing in PC clones and computer monitors was hardly different from competing in TV sets or in chip assembly what mattered was a reputation as a reliable, low cost producer and assembly unit labor costs remained extremely low until 1987. Combined with the Yen appreciation after the Plaza agreement in September 1985, this meant that Korean assemblers could outcompete Japanese firms and could attract a large chunk of the rapidly growing OEM demand for cheap PC clones. In 1987, 15 of the then leading international computer firms were importing PCs from Korea on an OEM basis, including Espon, NCR, Computer Land, loading Edge and Olivetti (Evans and Tigre, 1989).

While the shift from high risk sectoral targeting to broader diffusion oriented policies still constitute a minority position among policy makers and bureaucrats. A typical example of such inertia can be found in 1992 project of the Ministry of Trade and Industry. Following negotiations with the ailing US mainframe computer company Unisys, the ministry accepted Unisys's proposal to transfer, for a hefty yet undisclosed fees, its mainframe manufacturing technologies to Korea. As part of its general localization effort, the ministry then in 1993 announced a five year mainframe localization program, which in words of the ministry, would enable Korea's computer industry — "to move into high end computers and away from price competitive personal computers"[53]. Hard nosed neoclassical economists who oppose for ideological reasons any type of industrial policy will love this quotation to show that such policies are fraught with errors, huge costs and disastrous pitfalls. Such conclusions, in our view, however, mask the real issues: the need to make as explicit as possible the conflicting interests and trade off involved in different policy approaches[54].

## 5. Conclusion

The new economic policy initiated in India in 1991 has lifted a number of crucial restrictions on the operations of the TNCs. The situation now is much more favorable for them in terms of permissible extent of foreign equity, spheres of operations, use of brand names nature of import and export activities etc. Now the TNCs can have 51 per cent foreign equity automatically in a large number of industries specified in the Appendix and also in other industries with the government approval. All the industries are now open for the entry of new foreign investors, though for those not mentioned in the Appendix industries government permission is still necessary. FERA companies are no longer required to restrict their activities to the Appendix industries or to predominantly export-oriented activities. The restriction imposed by MRTP on expansion, merger, takeover etc. have been abolished. The TNCs are free to use their brand names also in the domestic markets. They are also free to decide whether they will export their output or use imported materials for their production here.

The TNCs have reacted favorably to the new economic policies to enter and grow in India. Several steps have been initiated which will enhance their managerial control and

[53] Quoted from Yearbook of World Electronics Data 1993, p. 178.

[54] For detailed analysis of these issues, see Ernst and O'Connor [1989].

market power at the cost of Indian entrepreneurs. India's current policies of lifting crucial restrictions on the TNCs amount to a passive reliance on the TNCs for economic development. None of the economically successful countries, whether Japan or Germany within the developed countries or South Korea, Taiwan or even Malaysia, Thailand within the less developed countries followed such a route. They do not provide the type of freedom to foreign enterprises which India is at present offering to them. During its recent phase of liberalization, even such a rich country as Japan did not indiscriminately lift controls on the western TNCs. Promoting Japanese enterprise continues to be a major objective. The policy planners did not open the investment doors until they felt that the Japanese enterprises are strong enough to compete with the foreign firms.

The new economic policy in India must be drastically changed. It is important to learn from the past mistakes and the experience of the other countries and among other things, regulate the TNCs keeping in mind the needs and the priorities of the country. A strategic intervention on the part of the government is required to take care of the negative features of the operations of the TNCs and to ensure that the country gains from their investments. Now it has become necessary for the national laboratories to reorganize priority for research in order to take the brunt of liberalization. India should concentrate on selected areas of research where it has build the capabilities and excellence and try to establish strong linkages with the industry to make value additions in the imported technologies to catch up the advances in technology abroad and compete in the international market. Korea has made tremendous progress over the last one decade to follow the policy of target oriented exports and make value additions in the imported technologies.

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# ЭМПИРИЧЕСКОЕ ИЗМЕРЕНИЕ РОССИЙСКОЙ НАУКИ

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World science, especially in developed countries, is going to the new form of organization and assessment of scientific activity. Unfortunately, our science is lagging with assimilation of positive innovations.

***Keywords:*** academic science, post-Soviet transformation, lagging, innovations

## Social processes in Russian academic science during the post-Soviet decades
### The results of sociological research[1]

Last two decades the reality in Russia clearly fits the notion of “unstable times”. The collapse of the Soviet Union (1991) has provoked serious political and socio-economic changes in all spheres of Russian life. The subject of our study was and is the **domestic academic science — the professional activity of scientists** working in the research institutes of the Russian Academy of Sciences (RAS). From 1994 to the present time our sector of Sociology of Science, which belong to Institute of the History of Science and Technology RAS, realized a monitoring of this phenomenon. Monitoring was based on regular sociological interrogations in representative groups of academic scientists and systematic analysis of data collected in these surveys. In 1990-ies the transformations in the political and socio-economic spheres were continuous. A long time academics are also expected to upgrade their sphere — science. However, during this period the State has ceased to be interested in science: funding (which has always been the only state one) declined sharply, many scientific organizations were liquidated. Academy of Sciences, as the focus of national basic research is preserved (converted from the USSR in the RAS). The scientists of academic institutions

[1] This work was made with the permanent support by grants of Russian Foundation for Humanity. The article has been prepared on the base of report for the X ESA Conference *Social Relations in Turbulent Times*, Geneva, 2011 and owing to RFH grant № 11-03-00818a.

eked out a miserable existence and waited for state reform of science. Finally, this long-awaited reform, from which all scientists were waiting a modernization, it was held only in 2006–2008. The reform was realized, but it results have shown for scientists that not every reform have to lead to modernization.

Most scientists are unhappy with the results of reform, combined data of these years survey showed that the vast majority — 96 % of scientists (both managers and performers) — at the final stage of the reform treated it negatively. Taking rising wages as a necessary but long overdue action, almost all of them said that it will not add to their interest in the work (90 %) and did not give additional motivation to the more hard work (92 %). A large proportion of respondents (72 %) expressed irritation connected with unprofessional approach which was revealed in many concrete proposals for reform coming from the government.

Scientists were disappointed that the main, in their view, the task of reform — the *modernization* of science system — has not been implemented, and in fact, as became clear, a program for reform had not implied it. Well understanding that the impact of science depends on an adequate combination of formal institutional actions with the structures of self-organization of scientific activity, most of the scientists is left to his own opinion: for a successful science requires its true modernization, which is not reducible to an increase in salary.

Outcome of the reform did not give the significant reasons for optimism, but scientists have always reserve hope for a positive outlook. An important result of the reform was the common comprehension of the fact that the modernization will not be conducted "from above" — it must be made by those people who really need to update the organization of innovative science and research activities, i. e. by academic community itself. Initially, the activity of scientists in an attempt to achieve modernization of the national science by them own was quite high. But gradually, recognizing the complexity and dimension of this task, they moved to their ordinary daily activity, projecting "to study this issue". This situation makes very important and actual ***a study of the principal innovations typical for the world science, as well as the deep analysis of their relevant implementation in our Academy.***

* * *

Usually the science is perceived as a *subject* of innovation. Scientific research are creating the new knowledge; in the process of development (R&D) it transforms into the latest technology and then — in production. Integrally all this is innovation. From academic science which is the focus of national basic research, of course, society expects the same. But that in the innovation chain, it could be productive, it itself should be at the forefront of scientific and technological progress, updating the character of its own operations, introducing its "internal innovation". In recent years, innovative activities are carried out in all the larger scale and in different forms, respectively there are new concepts — "innovation climate" (IR), "innovative potential" (IP), etc. Our analysis has revealed the innovations, which are most important for the Russian academic science (these ones were confirmed by opinions of the majority of respondents — the leading scientists of the RAS).

They are:

1) new types of organization and evaluation of research,
2) modern forms of research funding,
3) rejuvenation of staff,
4) update the instrument base,
5) modern information and communication support (ICTs).



Apparently, the focus should be on them. The above list is built "top-down", i. e. lower in the list is an innovation, the less innovative potential. Both of these indicators (and IE, and IR) — are the integrated indicators calculated by the combination of parameters. Without going into details, we restrict our intuitive understanding of these expressions (it is enough).

Suppose that we agree with such a distribution of the importance of these innovations (there are also other ones). It is interesting to find out how scientists assess the degree of assimilation of various innovations in their institutions. To unify the interviewing we used a single "Questionnaire" on which was held for more than 20 in-depth interviews with leading scientists of natural science institutes. In particular, the researchers evaluated the IR — the level of assimilation of innovators in the academic science of the Russian "school system" — from 1 (min) to 5 (max) points.

The scientists estimated them as follows:

*development of information and communication technology (ICTs)* — 4.3 points;
*election financing* — 3.2 points,
*rejuvenation rate* — 2.2 points;
*permanent updating of the instrument base* — 2.1 points;
*new kinds of organization and assessment of scientific activity* — 1.2 points.

Of course, that are the *average* results, but it should be noted that the difference between estimates in different institutions was very low. If we average once more, this next average score of the innovation climate (on our scale) is 2.6 points, i. e. on school terminology — "2+". So, the most important innovation — *new forms of organization and assessment of scientific activity* advances in the weakest way. And the fact that experts at first thought the simplest (purely technological innovation) — *the development and improvement of information and communication technologies*, not only had the maximum assimilation, but also strongly supported our science in difficult times.

Sociologists implementing the project leaved traces and recorded the emergence, development and deployment of ICTs with special care. It was a real INNOVATION, which came into the national academic science before our eyes, gradually assimilated, the object of desire for ones and relentless hostility for others, a symbol of elitism, a toy and a beautiful assistant in the work! But for sociologists — a unique case-study of the dynamics of tradition and innovation, seen with their own eyes, and fixed in their own questionnaires.

The latest information and communication technologies are one of the main factors of modernization of science. And their use in the scientific community of RAS was continuously growing since the 90's. This innovation has radically expanded the professional capabilities of scientists, but unfortunately, its productivity in the science itself during long time was not confirmed in an explicit form, although usually not questioned. Studying this innovation, we carefully recorded the dynamics of indicators characterizing not only the degree of ICTs usage, but also their impact on the productivity of professional scientists.

Enough mass appeal of Russian research community to ICTs was first noticed in the test-survey of academic institutions in 1994. A year later, in survey 1995, we have already fixed the significance of this new factor, so that length of time can be considered as an initial phase of development of computer mediated telecommunications. Year after year, assimilation of innovations enlarged: a growing interest of users and intensity of use, expanded geography of contacts, and an assortment of commonly used services. By 1998, all of the leading academic institutions connected to the Internet, and the survey

of this time showed qualitative changes which the latest ICTs introduced into research activity. From a means of interpersonal communication, which were often decided by the scientific and organizational problems, there were also the most responsive source of scientific information. Exactly, *information* and *communication* compose the basis of productivity of scientist. Many new features, such as the use of international data-bases, participate in global trade networks, setting out its tasks to other people's computers, etc., etc. And these opportunities were actually used, which was clearly documented by empirical evidence.

Only one impatiently waiting result did not manifest itself. Not only in 1995 but also in 1998, data processing was not identified positive effects of ICTs on the professional productivity of scientists. Both surveys showed the same correlation: the scientists who were most actively and successfully engaged in scientific work, were also active users of ICTs, but an inverse relationship was absent — "super active" in the ICTs group was weaker for scientific achievements of other users. AND minimally active group of users of ICTs showed excellent academic results, especially for the publication indicator. All this lead to the conclusion that the active use of ICTs is rather the *consequence* of a common professional activity but not the *cause* of professional success scientists.

After 1998, no radical events in the academic system of RAS was not happening. Over time, innovation has become a familiar comfort. Everyone understood that it speeds up certain kinds of work, but sociologists trusted their data and knew, to their regret, that this innovation does ***not increase*** the productivity of scientific activity. It was unclear and provoked disturbance, so, in 2001/02, a third survey was made with special attention to this phenomenon. Apparently, the past years were the time of ripening stage for results of innovation. Data obtained in this survey were non-trivial and have revealed exactly a long-awaited law.

This survey, fixing up the three years since the previous one, has clearly demonstrated a radical change in the role of ICTs in research teams. Completely in all groups of respondents appeared stable positive correlation between the use of ICTs and professional productivity. Major users of ICTs significantly improved their productivity as the increase of number of publications and reports and participation in international grants. Extra-active ICTs team took first place and on indicators of professional performance. And previously successful team which little use ICTs significantly lost its effectiveness. So, on the basis of empirical evidence 10-year monitoring of concrete innovation, there was first shown unequivocally positive final correlation between the degree of involvement of the scientists in the ICTs and their professional success (*Mirskaya,* 2009; *Mirskaya,* 2010).

But innovations also have their own development and it is impossible to satisfy the needs of scientists in communication and information technologies once and for all. Constant updating of information and communication infrastructure of national science is necessary even in order to keep abreast of international scientific information and to maintain international contacts. Therefore, our prospects for success in the global science seriously linked to the emphasis in the near future will be on further implementation and, most importantly — the development of advanced information and communication technologies. Our complex history of this innovation has one simple conclusion: do not rush to assess the impact of innovations. Their prospects have to be carefully weighed beforehand, but then do not rush the evaluation: that is impossible to receive "all at once".



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# Russian Mathematical Journals in World and National Corpora of Scientific Journals: bibliometric analysis

*In memoriam of Vladimir Arnold*

The present paper is devoted to a discussion of results of the bibliometric analysis of a number of mathematical journals (more than 700) and scientific fields of knowledge (more than 50) in the JCR databases for the 1998–2010 period. An attempt is made to assess Russian journals in the mathematical sciences in the world and national corporaofscientificjournalsby the impact factor Ip and the normalized impact factor K.

***Keywords:*** bibliometric analysis, mathematical journals, Normalized Impact Factor K, Impact factor, ranking lists, ISI Web of Knowledge: Journal Citation Reports Science Edition

## Introduction

Since the beginning of the 1960-ies, a new direction in the study of science has been gaining ground — the quantitative analysis of information flows (bibliometrics). (Some precedents of bibliometric studies go back to 1917). A specific feature of bibliometrics is the use of secondary information: all kinds of bibliographic indexes, abstracts, etc. The corresponding statistics are of substantial interest for the analysts of the development of science, they can help in the planning and management of science. The objects counted in bibliometrics are authors, journals, thematic groupings, organizations, words, etc. Bibliometrics is aimed at the quantitative analysis of documentary output in science as a whole or in specific fields of science. The bibliometric approach opens new vistas for the study of science, supplying it with an empirical base covering both the science's past and (which is especially important) the forefront of science in the making.

Citation analysis is a standard bibliometric instrument very popular in the study of science. It is usually conducted in order to 1) retrieve documents; 2) use the corresponding information for evaluating the impact of papers, journals, countries, etc. (this is the most popular bibliometric research, it is based on citation data); 3) use co-citation information in the study of the structure of science or a scientific field. Better understanding of the development of science can be achieved with the help of such new tools as models of citation in scientific periodicals, co-citation maps of papers and authors, dynamical analysis of thematic regions, techniques of lexical monitoring of science (dynamics of word use, interrelations of keywords, etc.)

Various bibliometric methods fall into two major approaches. The first is based on the analysis of the dynamics of individual features: "plain bibliometrics". The second is associated with the study of the correlation between objects, their clustering and classification: "structural bibliometrics". The development of both approaches in bibliometric studies was greatly facilitated with the advent of the ISI/Thomson Reuters systems, which are a universal (world-wide and polythematic) information base.

In this study, the methods of plain bibliometrics were used for the assessment of scientific journals in the mathematical fields of science.

## 1. Bibliometric analysis of scientific journals

The structure of the ISI/Thomson Reuters database — Journal Citation Reports (JCR) gave rise to some fine bibliometric tools for the analysis of scientific journals. Perhaps the best example of such new indicators is the *Impact Factor* and *Immediacy Index*. The first indicator reflects the average citation of papers from a given journal (during the last two years). The immediacy index is 'a measure of how quickly "the average cited article" in a particular journal is cited'. Both indices measure the importance and prestige of a journal with in the professional community. They rapidly became popular among librarians as guidelines for selecting the most effective journals for big libraries and information centers (see Marshakova-Shaikevich, 2008: 166–175). The analysis of scientific periodicals is a very popular field of study not only in Information and Library Science. Bibliometric analysis of scientific journals was always at the focus of attention of researchers from different fields of science as well as of sociologists of science. The very existence of JCR provides a unique possibility for this kind of research. E. Garfield (Garfield, 2006: 90–93) wrote that "I first mentioned the idea of impact factor in *Science* in 1955... In the early 1960s, Irving H. Sher and I created the journal impact factor to help select journals for the new *Science Citation Index* (SCI)".

The evaluation of scientific journals was always one of the main tasks of bibliometric and webometric studies. A search of the SCI for the term "impact factor" produces 1,187 papers for the period 1996–2008. There are 48 papers, which present basic concepts, using and modifying the impact factor and also addressing critical issues in the Scientometrics Guidebook (Scientometrics Guidebook Series, 2007).

The Journal Citation Reports served as a basis for further invariant or integrative indicators, such as the 'discipline impact factor' of Hirst (Hirst, 1978: 171–172), or the 'total citation influence measure' (Narin, Pinsski, Gee, 1976). This contributed to a better understanding of the cognitive structure of the field under study and, as a rule, helped to identify the range of scientific journals of importance in particular fields. On the basis of the total



influence measure, Narin has advanced the principle of hierarchical structure of scientific periodicals within subject fields. Using JCR data for journals on human and medical genetics, A. Pudovkin and E. Garfield (Pudovkin, Garfield, 2002: 1113–1110) calculated their 'relatedness factor' (RF) of the leading periodicals in the field of Genetics.

The main goal of the present study is the bibliometric assessment of Russian journals of the mathematical sciences in the world and in the corpora of Russian scientific journals. Special attention in the present article is paid to the *Russian Journal of Mathematical Physics* (RJMP). Material for this study was drawn from **DBs ISI Web of Kowledge: Journal Citation Reports Science Edition** for the 1998–2010 periods (ISI Web of Knowledge: Journal Citation Reports: Science Edition, 2008–2010).

## 2. Normalization of the impact factor for the assessment of journals

The impact factor (Ip) given by JCR may be regarded a measure of the mean citedness of a journal. In the annual JCR databases it is calculated as follows: the sum of cites of the current year to publications of the given journal in the two preceding years is divided by the total number of publications in that journal during those two years. To take a concrete example, in 2010 RJMP got 112 cites to the journal's articles published in 2009 and 2008. The total number of articles published in the journal in the years 2008 and 2009 was 49 and 50, respectively. Thus the impact factor is 112 / 99 = 1.131

| | | | | |
|---|---|---|---|---|
| Cites in 2010 to items published in: | 2009 = 51 | | Number of items published in: | 2009 = 49 |
| | 2008 = 61 | | | 2008 = 50 |
| | Sum: 112 | | | Sum: 99 |

Calculation: $\frac{\text{Cites to recentitems}}{\text{Number of recentitems}} = \frac{112}{99} = \mathbf{1.131}$

In the present study a special measure — the *normalized impact factor* (K) is also used. The JCR databases cover more than 170 fields of science and include about eight thousand scientific journals. It is well known that the level of citedness differs significantly across various fields of science: e.g. it is very high in biology and medicine and very low in mathematics or engineering. Therefore the traditional impact factor (Ip) of a journal, as it is indicated in JCR, would be valid only within large fields of science. To facilitate the cross-field evaluation of particular journals, the new measure K is introduced as follows: the Ip of a journal is divided by the *standard impact factor* (Ig) *of the field* to which this journal belongs. The technique of calculation of the standard impact factor for a field is an inherent part of the method and is of independent interest.

## 3. The standard impact factor for particular fields of science (Ig)

For each field of science, five journals with the highest Ip values were selected. If the total number of papers in those journals (for the two preceding years) was less than 500, the number of journals was extended until the threshold of 500 was reached. The ratio of

the total number of citations (in JCR source journals) of articles in the selected journals to the total number of source items in those journals represents the field as a whole; it is called the *standard impact factor of the field* and is denoted by (Ig). As has been just mentioned, in the calculation of both Ip and Ig, the number (R) of current year citations is divided by the number of items (S) in the two preceding years.

The following is an example of the calculation of the standard impact factor (Ig) in the field of mathematics in 2009:

| MATHEMATICS Ig = 3.06 | | | |
|---|---|---|---|
| **Ip** | Journaltitle | ΣR | ΣS |
| 4.174 | ANN MATH | 359 | 86 |
| 3.411 | J AM MATH SOC | 249 | 73 |
| 3.294 | B AM MATH SOC | 112 | 34 |
| 2.794 | INVENT MATH | 380 | 136 |
| 2.657 | COMMUN PUR APPL MATH | 271 | 102 |
| 2.619 | ACTA MATH-DJURSHOLM | 55 | 21 |
| 2.240 | MEM AM MATH SOC | 112 | 50 |

These calculated indicators may serve as a valuable addition to the JCR database. The standard impact factor Ig of a field can measure the rate of progress in that field. In science, fields with growing Ig might be called 'leading' fields. Below we follow the division of science into the research fields used in the JCR databases (the fields are called *categories* there).

## 4. Normalized impact factor of a journal

Once the standard impact factor of the field is obtained, the numerical assessment of a particular journal becomes evident. The most obvious and simple indicator is the ratio of the two measures:

**K= (Ip / Ig) x 100%;** this is the *normalized impact factor* of the journal.

If a journal belongs to two or more fields, then, instead of Ig, the arithmetic mean I'g of the two or more Ig's must be used I'g = (Igi + Igj + ... Ign) / n, where *n* is number of fields of science ("categories") in which the journal is indexed in the JCR databases. For example, in 2009 the journal *CHAOS SOLITON FRACT* (Ip = 3.315) was indexed in the three following JRC categories:

MATHEMATICS, INTERDISCIPLINARY APPLICATIONS (JCR code PO): Ig = 3.27
PHYSICS, MATHEMATICAL (UR): Ig = 2.67
PHYSICS, MULTIDISCIPLINARY (UI): Ig = 17.5

The arithmetic mean is I'g = 7.8, the normalized impact factor is K = (3.27 / 7.8)×100 = 42.5. We can write:

| Abbr. Journal title | JCR Categories | I'g |
|---|---|---|
| *CHAOS SOLITON FRACT* | PO, UR, UI | 7.8 |



In the next table, this journal is compared to some journals in mathematic and physics. This procedure was applied to the JCR database (Science Edition) for 2008–2010. The normalized impact factor (K) may prove to be a better measure of journal's impact than the traditional impact factor (Ip) of a scientific journal. The difference between the two factors in the evaluation of journals is striking. In 2009, the journals in the first two groups differ slightly in their Ip values (within the group), while the differences in K are sometimes astounding. On the other hand, the journals in the last two groups differ very much in their Ip values (JETP LETT + 1.66 and PMM-J APPL MATH MEC0.36), but are quite comparable as far as K (9.50 and 9.52) is concerned:

| Abbr. Journal title | Ip | K |
|---|---|---|
| RUSS J MATH PHYS | 0.85 | 31.8 |
| THEOR MATH PHYS + | 0.80 | 7.9 |
| | | |
| SIAM REV | 3.39 | 109.7 |
| CHAOS SOLITON FRACT | 3.31 | 42.5 |
| | | |
| JETP LETT+ | 1.66 | 9.50 |
| PMM-J APPL MATH MEC+ | 0.36 | 9.52 |
| | | |
| PHYS ATOM NUCL+ | 0.54 | 15.40 |
| PHYS-USP+ | 2.63 | 15.02 |

(In this table and in the tables below, the plus sign (+) after the title of a Russian journal indicates that it is published both in English and Russian.) The standard impact factor for particular fields of science (Ig) and the normalized impact factor K were first introduced in 1988 to evaluate Soviet scientific periodicals. Without it, the cross-disciplinary comparison of periodicals is quite impossible, owing to the exceptionally great inter-field variance of the individual impact factors. This method was first published in the author's works in Russian (Marshakova, 1988) and later in English (Marshakova-Shaikevich, 1996: 283–290). The procedure was applied to the JCR database for 1992, then for 1998–2002 in (Marshakova-Shaikevich Irina and Heinz Michael, 2008: 37–45; Marshakova-Shaikevich, 2009). The normalized impact factor was used for the evaluation all social journals in **JCR databases (Social Science Edition)** for 1994–2004 by Drabek and Marshakova-Shaikevich (Drabek, Marshakova-Shaikevich, 2007: 88–104).

The normalized impact factor may be used as a standard indicator in forming particular databases. The financing of science in most countries demands great circumspection in the choice of scientific journals for subscription; the normalized measures Ig and K may be quite useful in this respect.

## 5. Dynamics of research fields of science

The annual calculation of the standard impact factor of particular fields (Ig) helps to monitor new tendencies in the development of science and to compare science policies of various nations. The analysis of the priority programs of the Russian ministry of science

showed that in the period of *perestroika* (1985–1992) the list of programs was on the whole well correlated with the list of the most dynamic fields of world science; however, the share of financial support going to specific programs was in no way connected with the significance and dynamics of the corresponding field. Even with national priorities taken into account, the correlation between bibliometric indicators and financial support should not have been violated to such an extent. The impact factor of fields could be used in systems of grant distribution financed by national or international committee scientific programs (for example, RFBR).

An interesting aspect of the study of science is the analysis of the dynamics of Ig in particular categories. One should analyze the figures for specific categories, keeping in mind the growth of K for all categories in the period under consideration:

| | 1998–2002 | 2003–2005 | 2008–2009 |
|---|---|---|---|
| I'g (average Ig) | 3.77 | 4.83 | 5.60 |

The 50 per cent growth in a decade may be explained by social aspects of the present day situation: the Internet revolution in communications facilitates access to all sources of information; the lists of cited literature grow.

The dynamics of I'g (average Ig) for three cumulative periods 1998–2009 is shown in Table 1 for some fields of science and in Figure1 for four fields of the mathematical sciences, including the category *Physics, mathematical* (UR).

**Table 1.** I'g (average Ig) for some fields of science in 1998–2009

| Code | JCR categories | Ig' (average Ig) | | |
|---|---|---|---|---|
| | | 1998–2002 | 2003–2005 | 2008–2009 |
| EX | COMPUTER SCIENCE, THEORY & METHODS | 1.93 | 2.97 | 3.69 |
| IF | ENGINEERING, MULTIDISCIPLINARY (Engineering) | 1,29 | 1,97 | 3,36 |
| MCB | MATHEMATICAL & COMPUTATIONAL BIOLOGY | — | — | 4,34 |
| PQ | MATHEMATICS | 1,53 | 1,84 | 2,96 |
| PN | MATHEMATICS, APPLIED | 1,8 | 2,06 | 3,78 |
| PO | MATHEMATICS, INTERDISCIPLINARY APPLICATIONS | 1,49 | 5,06 | 3,29 |
| PU | MECHANICS | 2,26 | 2,93 | 4,91 |
| PT | MEDICAL INFORMATICS | 1,59 | 1,83 | 3,16 |
| UR | PHYSICS, MATHEMATICAL | 2,02 | 2,28 | 3,01 |
| UI | PHYSICS, MULTIDISCIPLINARY | 6,69 | 7,6 | 12,71 |
| XY | STATISTICS & PROBABILITY | 1,76 | 4,8 | 3,17 |

**Table 2** and **Figure 2** present the standard impact factor of fields (Ig) for8 categories in the last period 2008–2010.



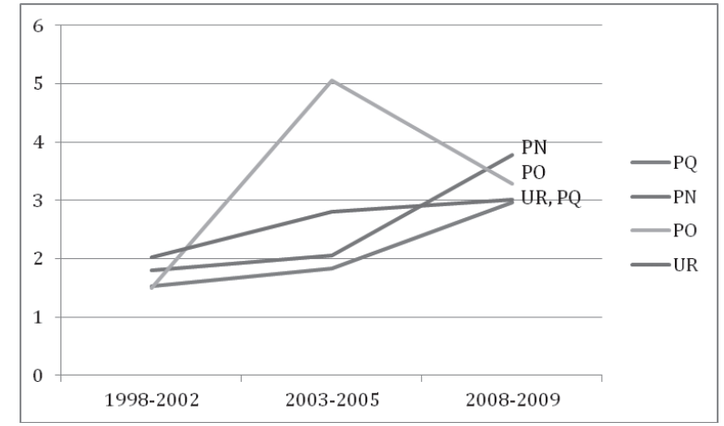


**Fig.1.** Dynamics of Ig' for four mathematical fields of science

**Table 2.** Standard impact factor of fields (Ig) for 8 categories in 2008–2010

| JCR categories | JCR code | Ig 2008 | Ig 2009 | Ig 2010 |
|---|---|---|---|---|
| COMPUTER SCIENCE, THEORY & METHODS | EX | 3.90 | 3.47 | 3.42 |
| STATISTICS & PROBABILITY | XY | 2.91 | 3.42 | 2.99 |
| MATHEMATICS | PQ | 2.85 | 3.06 | 2.81 |
| MATHEMATICS, APPLIED | PN | 4.48 | 3.09 | 3.49 |
| MATHEMATICS, INTERDISCIPLINARY APPLICATIONS | PO | 3.32 | 3.27 | 4.94 |
| PHYSICS, MATHEMATICAL | UR | 3.36 | 2.67 | 2.42 |
| MATHEMATICAL & COMPUTATIONAL BIOLOGY | MCB | 4.27 | 4.41 | 4.17 |
| MECHANICS | PU | 5.34 | 4.48 | 4.04 |

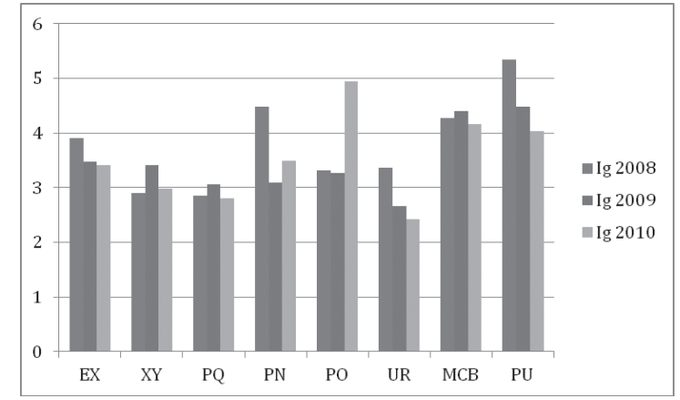


**Fig.2.** Dynamics of Ig in 2008–2010 for 8 categories

Table 2 shows the values of Ig in 4 mathematical categories: MATHEMATICS, APPLIED (JRC code PN), MATHEMATICS, INTERDISCIPLINARY APPLICATIONS (PO), MATHEMATICS (PQ), PHYSICS, MATHEMATICAL (UR) and 4 categories related tothem: COMPUTER SCIENCE, THEORY & METHODS (EX), STATISTICS & PROBABILITY (XY), MECHANICS (PU) and MATHEMATICAL & COMPUTATIONAL BIOLOGY (MCB).

The new category (MATHEMATICAL & COMPUTATIONAL BIOLOGY, Table 2) appeared in 2008. Only two of its journals are members of the new group and of no other, while 27 journals are included in other categories as well. From time to time the classification scheme of JCR is changed. As a rule a broad (often interdisciplinary) category is split into narrower categories. This is a common procedure in biomedicine. As far as mathematical journals are concerned, one can mention the split of the MATHEMATICS, APPLIED category. In 1982 it was divided into APPLIED MATHEMATICS proper and COMPUTER APPLICATIONS&CYBERNETICS. In the 1990s, the latter category constituted a broad field, which was ultimately split into seven categories of Computer Science:

ARTIFICIAL INTELLIGENCE (EP), CYBERNETICS (ER),
HARDWARE & ARCHITECTURE (ES),
INFORMATION SYSTEMS (ET), INTERDISCIPLINARY APPLICATIONS (EV),
SOFTWARE ENGINEERING (EW), THEORY & METHODS (EX).

Many mathematical journals indexed in the categories PQ, PN and PO have also become part of some categories of Computer Science. For example, ACM T MATH SOFTWARE (PN, EW), SIAM J COMPUT (PN, EX), J MATH IMAGING VIS (PN, EP, EW).

The calculated values of Ig do not depend on the number of journals in the field. Two large fields of knowledge, ENGINEERING, MULTIDISCIPLINARY and PHYSICS, MULTIDISCIPLINARY, have the same number of journals (79 and 71), but their values of Ig are quite different (3.17 and 17.5). Some other examples are given below:

| JRC category | Number of journals | Ig 2009 |
|---|---|---|
| COMPUTER SCIENCE, THEORY & METHODS | 92 | 3.47 |
| STATISTICS & PROBABILITY | 100 | 3.42 |
| MEDICAL INFORMATICS | 23 | 3.31 |
| ENGINEERING, MULTIDISCIPLINARY (Engineering) | 79 | 3.17 |
| MATHEMATICS | 255 | 3.06 |
| MATHEMATICS, APPLIED | 204 | 3.09 |
| MATHEMATICS, INTERDISCIPLINARY APPLICATIONS | 80 | 3.27 |
| PHYSICS, MATHEMATICAL | 47 | 2.67 |
| MATHEMATICAL & COMPUTATIONAL BIOLOGY | 29 | 4.41 |
| MECHANICS | 123 | 4.48 |
| PHYSICS, MULTIDISCIPLINARY | 71 | 17.5 |



## 6. Bibliometric assessment of mathematical science journals in JCR for 2008–2009

This section is devoted to discussion of calculation results of the normalized impact factor K for 615 journals included in five categories: MATHEMATICS (PQ), MATHEMATICS, APPLIED (PN), MATHEMATICS, INTERDISCIPLINARY APPLICATIONS (PO), MATHEMATICAL & COMPUTATIONAL BIOLOGY (MCB), and PHYSICS, MATHEMATICAL (UR).

About a hundred journals belong simultaneously to two or more categories. Two journals are indexed in six categories:

| Abbr. title of journal | Code category | Ip | K |
|---|---|---|---|
| J CHEMOMETR | **PO**, AC, EA, EP, OA, XY | 1.291 | 33.79 |
| OPEN SYST INF DYN | **UR**, DT, ET, PN, PU, XY | 0.935 | 27.18 |

This practice is quite common in the new category MCB. Ofthe 29 journalsbelongingto MCB, only two journals are not indexed in any other category: 7 journals are covered in three categories, 3 journals, in four categories and 4 journals, in five categories. Thus the average number of categories per journals (ACJ) is 2.7. The multidisciplinary character of MCB is evident. One may expect further reclassification of the field. The PHYSICS, MATHEMATICAL
(UR) category is also highly multidisciplinary, its ACJ is 2.2.

The distribution of mathematical journals by values of K for 2009is given below:

| ZONE | Values of Normalized impact factor K | Number of mathematical journals in fields | | | | |
|---|---|---|---|---|---|---|
| | | PN (204) | PO (80) | PQ (255) | UR (47) | MCB (29) |
| 1 | K > 100 | 4 | 1 | 1 | 1 | 0 |
| 2 | 100 < K > 50 | 27 | 9 | 12 | 17 | 2 |
| 3 | < 50 K > 20 | 111 | 43 | 125 | 19 | 20 |
| 4 | < 20 K > 10 | 56 | 20 | 99 | 6 | 4 |
| 5 | < 10 K > 0 | 6 | 7 | 18 | 4 | 1 |
| 6 | K= 0 | 0 | 0 | 0 | 0 | 0 |

**Table 3** below includes 32 mathematical journals (PN, PO, PQ, and MCB) with K>50 ranked by normalized impact factor.

**Table 3.** Mathematical (PQ, PN, PO, MCB) journals with K > 50 (JCR database for 2009)

| Rank | Abbreviated Journal Title | Code JCR category | Impact Factor | K 2009 |
|---|---|---|---|---|
| 1 | INT J NONLIN SCI NUM | PN, PU, IF, UR | 5.276 | 157.49 |
| 2 | ANN MATH | PQ | 4.174 | 136.40 |
| 3 | ECONOMETRICA | PO, XY | 4.000 | 119.76 |

| | | | | |
|---|---|---|---|---|
| 4 | SIAM REV | PN | 3.391 | 109.74 |
| 5 | B AM MATH SOC | PN | 3.294 | 106.60 |
| 6 | J AM MATH SOC | PN, EX | 3.411 | 103.99 |
| 7 | STRUCT EQU MODELING | PO | 3.153 | 96.42 |
| 8 | BMC SYST BIOL | MCB | 4.064 | 92.15 |
| 9 | INVENT MATH | PQ | 2.794 | 91.31 |
| 10 | COMMUN PUR APPL MATH | PQ, PN | 2.657 | 86.55 |
| 11 | ACTA MATH-DJURSHOLM | PQ | 2.619 | 85.59 |
| 12 | PLOS COMPUT BIOL | MCB, CO | 5.759 | 85.57 |
| 13 | BIOSTATISTICS | MCB, XY | 3.246 | 83.23 |
| 14 | SIAM J MATRIX ANAL A | PN | 2.411 | 78.02 |
| 15 | NONLINEAR ANAL-REAL | PN | 2.381 | 77.05 |
| 16 | MULTISCALE MODEL SIM | PO, UR | 2.198 | 74.01 |
| 17 | MEM AM MATH SOC | PQ | 2.240 | 73.20 |
| 18 | ABSTR APPL ANAL | PN | 2.221 | 71.88 |
| 19 | MULTIVAR BEHAV RES | PO, XY | 2.328 | 69.70 |
| 20 | STAT METHODS MED RES | MCB, HL, PT, XY | 2.569 | 68.87 |
| 21 | MATH MOD METH APPL S | PN | 2.095 | 67.80 |
| 22 | INVERSE PROBL | PN, UR | 1.900 | 65.97 |
| 23 | MATH PROGRAM | PN, EW, PE | 2.048 | 65.22 |
| 24 | APPL COMPUT HARMON A | PN, UR | 1.854 | 64.37 |
| 25 | FUZZY SET SYST | PN, XY, EX | 2.138 | 64.20 |
| 26 | INVERSE PROBL IMAG | PN, UR | 1.831 | 63.57 |
| 27 | FOUND COMPUT MATH | PQ, PN, EX | 1.905 | 63.08 |
| 28 | INT J NUMER METH ENG | PO, IF | 2.025 | 62.89 |
| 29 | CHAOS | PN, UR | 1.795 | 62.33 |
| 30 | SIAM J APPL DYN SYST | PN, UR | 1.786 | 62.01 |
| 31 | J CRYPTOL | PN, EX, IQ | 2.297 | 61.42 |
| 32 | ARCH RATION MECH AN | PO, PU | 2.331 | 60.23 |

The 13 leading Russian journals in the same categories occupy very modest ranks (239-488) in this list (which contains 491 journals).

| | | | | |
|---|---|---|---|---|
| | RUSSIAN JOURNALS | | | |
| 239 | MOSC MATH J | PQ, PN | 0.712 | 23.30 |
| 280 | REGUL CHAOTIC DYN | PN, PU,UR | 0.725 | 21.26 |
| 292 | IZV MATH + | PQ | 0.635 | 20.75 |
| 380 | ALGEBR LOG+ | PQ | 0.479 | 15.65 |
| 385 | RUSS J NUMER ANAL M | PN, IF | 0.485 | 15.49 |
| 387 | SIBERIAN MATH J + | PQ | 0.475 | 15.47 |
| 413 | RUSS MATH SURV + | PQ | 0.425 | 13.88 |
| 440 | PROBL INFORM TRANSM+ | PM, EX | 0.393 | 11.98 |
| 457 | DIFF EQUAT+ | PQ | 0.339 | 11.08 |
| 458 | MATH NOTES + | PQ | 0.337 | 11.0 |
| 476 | PMM-J APPL MATH MEC+ | PN, PU | 0.360 | 9.52 |
| 477 | FUNCT ANAL APPL + | PQ PN | 0.289 | 9.32 |
| 488 | DOKL MATH | PQ | 0.162 | 5.29 |



In the *Physics, mathematical* (UR) category, there were 47 journals in 2009. The ranking of the 18 journals which have of values K greater than 50 is presented in Table 4 below. Here again the ranks of the three leading Russian journals in that category (including the Russian Journal of Mathematical Physics) are quite modest.

**Table 4.** PHYSICS, MATHEMATICAL category journals in 2009

| Rank | Abbreviated Journal Title | Code Ig | Impact Factor | K 2009 |
|---|---|---|---|---|
| 1 | INT J NONLIN SCI NUM | UR, PN, PU, IF | 5.276 | 157.49 |
| 2 | COMMUN COMPUT PHYS | UR | 2.077 | 77.79 |
| 3 | COMMUN MATH PHYS | UR | 2.067 | 77.41 |
| 4 | QUANTUM INF COMPUT | UR, EX, UP | 2.980 | 77.40 |
| 5 | J STAT MECH-THEORY E | UR, PU | 2.670 | 74.79 |
| 6 | J COMPUT PHYS | UR, EV | 2.369 | 74.26 |
| 7 | MULTISCALE MODEL SIM | UR, PO | 2.198 | 74.01 |
| 8 | PHYS REV E | UR, UF | 2.400 | 70.80 |
| 9 | INVERSE PROBL | UR, PN | 1.900 | 65.97 |
| 10 | APPL COMPUT HARMON A | UR, PN | 1.854 | 64.37 |
| 11 | INVERSE PROBL IMAG | UR, PN | 1.831 | 63.57 |
| 12 | CHAOS | UR, PN | 1.795 | 62.33 |
| 13 | SIAM J APPL DYN SYST | UR, PN | 1.786 | 62.01 |
| 14 | COMPUT PHYS COMMUN | UR, EV | 1.958 | 61.38 |
| 15 | INT J GEOM METHODS M | UR | 1.612 | 60.37 |
| 16 | J NONLINEAR SCI | UR, PN, PU | 1.816 | 53.25 |
| 17 | J STAT PHYS | UR | 1.390 | 52.06 |
| 18 | ADV THEOR MATH PHYS | UR, UP | 2.034 | 50.35 |
| | RUSSIAN JOURNALS | | | |
| 26 | RUSS J MATH PHYS | UR | 0.850 | 31.83 |
| 35 | REGUL CHAOTIC DYN | UR, UP | 0.725 | 21.26 |
| 44 | THEOR MATH PHYS + | UR, UI | 0.796 | 7.90 |

The geographical distribution of the 47 journals of the *Physics, mathematical* category is as follows: USA — 16, The Netherlands — 8, Singapore — 7, England — 6, Russia and Switzerland — 3, Germany, Poland, China and Ukraine — 1. Two Russian journals in this field — REGUL CHAOTIC DYN and RUSS J MATH PHYS are published only in English, THEOR MATH PHYS+ is published in Russian and translated into English.

## 7. Russian mathematical journals in the world corpus of scientific journals

In 2010[2] the Russian corpus of scientific journals included 147 journals (the corresponding figure for 2008 is 108, and for 2009, it is 123.In the list of Russian journals for 2010, there

[2] The JCR database (Science Edition) for 2010 has become accessible only in July 2011.

are 19 journals dealing with the mathematical sciences. Among them there are three new mathematical science journals:

COMPUTATIONAL MATHEMATICS AND MATHEMATICAL PHYSICS
(COMP MATH MATH PHYS+),
PROCEEDINGS OF THE STEKLOV INSTITUTE OF MATHEMATICS
(P STEKLOV I MATH),
ST PETERSBURG MATHEMATICAL JOURNAL (ST PETERSB MATH+).

Data on the19 journals in the mathematical sciences are presented in Table 5 below.

**Table 5.** Russian Mathematical Journals in JCR databases for 2008–2010

| Journal abbreviation | Category code | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|
| | | Ip | K | Ip | K | Ip | K |
| ALGEBR LOG+ | PQ | — | — | 0.479 | 15.65 | 0.455 | 16.19 |
| COMP MATH MATH PHYS+ | PN, UR | — | — | — | — | 0.380 | 12.88 |
| DIFF EQUAT+ | PQ | 0.437 | 15.33 | 0.339 | 11.08 | 0.369 | 13.13 |
| DOKL MATH | PQ | 0.222 | 7.79 | 0.162 | 5.29 | 0.204 | 7.26 |
| FUNCT ANAL APPL + | PQ, PN | 0.449 | 12.25 | 0.289 | 9.32 | 0.688 | 21.84 |
| IZV MATH + | PQ | 0.494 | 17.3 | 0.635 | 20.8 | 0.494 | 17.58 |
| MATH NOTES + | PQ | 0.270 | 9.5 | 0.337 | 11.0 | 0.344 | 12.24 |
| MOSC MATH J | PQ, PN | — | — | 0.712 | 23.3 | 0.721 | 22.89 |
| P STEKLOV I MATH+ | PQ, PN | — | — | — | — | 0.276 | 8.76 |
| PMM-J APPL MATH MEC+ | PN, PU | 0.348 | 7.09 | 0.360 | 9.52 | 0.352 | 9.36 |
| PROBL INFORM TRANSM+ | PM, EX | — | — | 0.393 | 11.98 | 0.418 | 12.11 |
| REGUL CHAOTIC DYN | PN, PU,UR | 0.568 | 12.94 | 0.725 | 21.26 | 0.529 | 15.93 |
| RUSS J MATH PHYS | UR | 0.944 | 28.09 | 0.850 | 31.83 | 1.131 | 46.73 |
| RUSS J NUMER ANAL M | PN, IF | 0.305 | 7.60 | 0.485 | 15.49 | 0.592 | 18.97 |
| RUSS MATH SURV + | PQ | 0.430 | 15.08 | 0.425 | 13.9 | 0.496 | 17.65 |
| SIBERIAN MATH J + | PQ | 0.445 | 15.61 | 0.475 | 15.5 | 0.388 | 13.81 |
| ST PETERSB MATH J+ | PQ | — | — | — | — | 0.347 | 12.35 |
| THEOR MATH PHYS+ | UR, UI | 0.721 | 11.52 | 0.796 | 7.90 | 0.748 | 13.50 |
| THEOR PROBAB APPL+ | XY | 0.698 | 23.97 | 0.827 | 24.18 | 0.318 | 10.63 |

The values of the standard impact factor Ig of some JCR categories in the mathematical sciences in 2008–2009 are shown in Table 6 below.

**Table 6**. Standard impact factor Ig for some JCR categories

| Code | Categories in JCR | Standard impact factor | | |
|---|---|---|---|---|
| | | 2008 | 2009 | 2010 |
| EX | COMPUTER SCIENCE, THEORY & METHODS | 3.90 | 3.47 | 3.42 |
| IF | ENGINEERING, MULTIDISCIPLINARY (Engineering) | 3.54 | 3.17 | 2.75 |
| PN | MATHEMATICS, APPLIED | 4.48 | 3.09 | 3.49 |



| | | | | |
|---|---|---|---|---|
| PO | MATHEMATICS, INTERDISCIPLINARY APPLICATIONS | 3.32 | 3.27 | 4.94 |
| PQ | MATHEMATICS | 2.85 | 3.06 | 2.81 |
| PU | MECHANICS | 5.34 | 4.48 | 4.04 |
| PT | MEDICAL INFORMATICS | 3.01 | 3.31 | 2.69 |
| UR | PHYSICS, MATHEMATICAL | 3.36 | 2.67 | 2.42 |
| UI | PHYSICS, MULTIDISCIPLINARY | 9.16 | 15.50 | 8.66 |
| XY | STATISTICS & PROBABILITY | 2.91 | 3.42 | 2.99 |

The dynamics of the normalized impact factor K for Russian journals in the mathematical sciences for the three years 2008–2009–2010 are presented in Figure 3 below. Note that RJMP has the highest values of K and the rate of growth of its normalized impact factor is quite substantial.

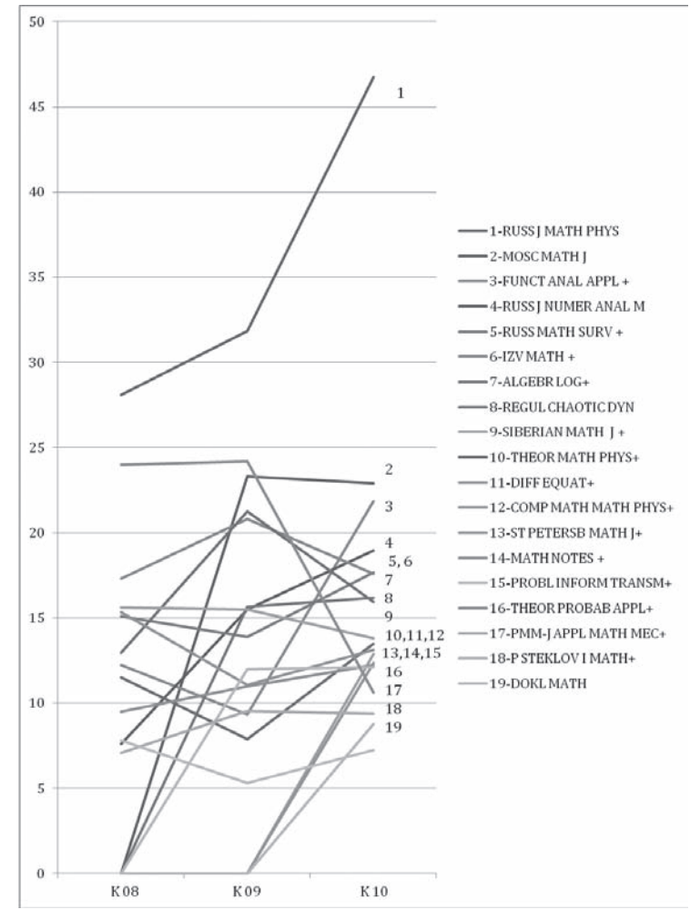


**Fig. 3.** Dynamics of K of the Russian journals in the mathematical sciences in 2008–2010

Let us examine changes in the values of the normalized impact factor K of Russian journals in the mathematical sciences in 2008, 2009 and 2010 (Fig. 3). We see that only three journals: RUSS J MATH PHYS, RUSS J NUMER ANALM and MATH NOTES+ had a stable growth of K; on the other hand, we see that two new journals: ALGEBR LOG+ and PROBL INFORM TRANSM+ had insignificant growth.

Figure 4 below shows the ranks of these journals according to their values of K in 2010.

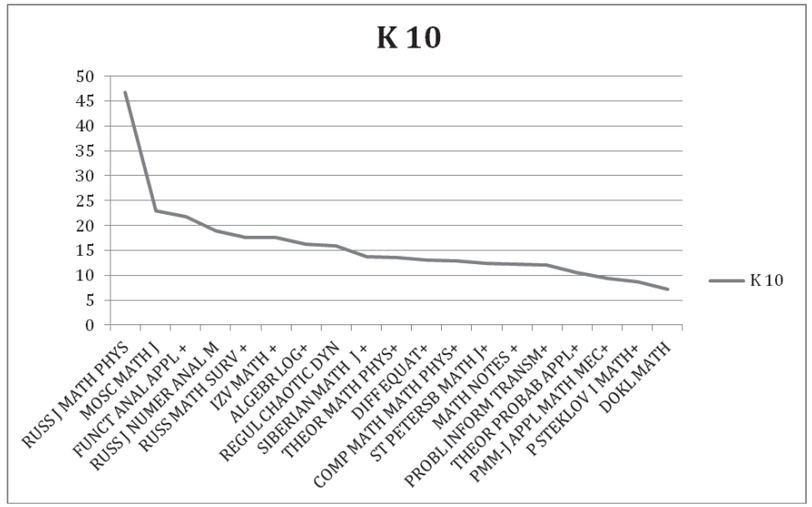


**Fig. 4.** Rankings by K of Russian journals in the mathematical sciences in 2010

This figure shows that only two journals have values of K between 20 and 40: RJMP and MOSC MATH J. Most Russian journals (14) have values of K between 10 and 20, while three have values of K less than 10.This is confirmed by Table 7 below, which also shows K', the average values of K in 2008–2010.This list is headed by three journals: RJMP, MOSC MATH J, and FUNCT ANAL APPL + with values of K in 2010 between 20 and 50.

**Table 7.** Normalized impact factor K (and its average K' for 2008–2010) for the same journals

| Journal abbr. | K 08 | K09 | K10 | Average K' |
|---|---|---|---|---|
| RUSS J MATH PHYS | 28.09 | 31.83 | 46.73 | 35.55 |
| MOSC MATH J | — | 23.3 | 22.89 | 23.09 |
| FUNCT ANAL APPL + | 12.25 | 9.32 | 21.84 | 14.47 |
| RUSS J NUMER ANAL M | 7.60 | 15.49 | 18.97 | 14.02 |
| RUSS MATH SURV + | 15.08 | 13.9 | 17.65 | 15.54 |
| IZV MATH + | 17.3 | 20.8 | 17.58 | 18.56 |
| ALGEBR LOG+ | — | 15.65 | 16.19 | 15.92 |



| | | | | |
|---|---|---|---|---|
| REGUL CHAOTIC DYN | 12.94 | 21.26 | 15.93 | 16.71 |
| SIBERIAN MATH J + | 15.61 | 15.5 | 13.81 | 14.97 |
| THEOR MATH PHYS+ | 11.52 | 7.90 | 13.50 | 10.97 |
| DIFF EQUAT+ | 15.33 | 11.08 | 13.13 | 13.18 |
| COMP MATH PHYS+ | — | — | 12.88 | 12.88 |
| ST PETERSB MATH J+ | — | — | 12.35 | 12.35 |
| MATH NOTES + | 9.5 | 11.0 | 12.24 | 10.91 |
| PROBL INFORM TRANSM+ | — | 11.98 | 12.11 | 12.04 |
| THEOR PROBAB APPL+ | 23.97 | 24.18 | 10.63 | 19.59 |
| PMM-J APPL MATH MEC+ | 7.09 | 9.52 | 9.36 | 8.66 |
| P STEKLOV I MATH+ | — | — | 8.76 | 8.76 |
| DOKL MATH | 7.79 | 5.29 | 7.26 | 6.78 |

## 8. Russian mathematical journals in the national corpus of scientific journals

The rankings of 50 Russian scientific journals by impact factor Ip and by normalized impact factor K are presented in Tables 8 and 9.The leader of the journals in the mathematical sciences comes 13th in the Ip list (Table 8), yet among the 10 leaders in the list ranked by the normalized impact factor K (Table 9), we find five (!) mathematical journals with K more than 20. In these two tables, the journals in the mathematical sciences are displayed in bold font.

**Table 8.** Ranking of Russian scientific journals by impact factor Ip in 2009

| Rank | Abbreviated Journal Title | Impact Factor | K 2009 |
|---|---|---|---|
| 1 | PHYS-USP+ | 2.628 | 15.02 |
| 2 | RUSS CHEM REV+ | 2.073 | 14.17 |
| 3 | JETP LETT+ | 1.662 | 9.50 |
| 4 | BIOCHEMISTRY-MOSCOW+ | 1.327 | 4.73 |
| 5 | GEOTECTONICS+ | 1.000 | 23.64 |
| 6 | RUSS GEOL GEOPHYS+ | 1.000 | 17.42 |
| 7 | COMP CYTOGENET | 0.973 | 5.03 |
| 8 | ASTRON LETT+ | 0.943 | 12.12 |
| 9 | PHYS PART NUCLEI+ | 0.935 | 17.28 |
| 10 | STRATIGR GEO CORREL+ | 0.915 | 30.35 |
| 11 | PETROLOGY+ | 0.912 | 15.89 |
| 12 | J EXP THEOR PHYS+ | 0.871 | 5.62 |
| 13 | RUSS J MATH PHYS | 0.850 | 31.83 |
| 14 | THEOR PROBAB APPL+ | 0.827 | 24.18 |
| 15 | THEOR MATH PHYS+ | 0.796 | 7.90 |
| 16 | QUANTUM ELECTRON+ | 0.791 | 10.37 |
| 17 | MENDELEEV COMMUN | 0.769 | 5.26 |
| 18 | ASTRON REP+ | 0.759 | 9.75 |

| 19 | J RUSS LASER RES | 0.748 | 19.63 |
|---|---|---|---|
| 20 | REGUL CHAOTIC DYN | 0.725 | 21.26 |
| 21 | ASTROPHYS BULL | 0.723 | 9.29 |
| 22 | PHYS SOLID STATE+ | 0.721 | 6.23 |
| 23 | MOSC MATH J | 0.712 | 23.19 |
| 24 | KINET CATAL+ | 0.691 | 5.92 |
| 25 | POLYM SCI SER A+ | 0.688 | 13.62 |
| 26 | LASER PHYS | 0.676 | 9.37 |
| 27 | APPL BIOCHEM MICRO+ | 0.670 | 4.40 |
| 28 | LOW TEMP PHYS+ | 0.662 | 6.23 |
| 29 | MICROBIOLOGY+ | 0.638 | 4.55 |
| 30 | SEMICONDUCTORS+ | 0.637 | 5.50 |
| 31 | IZV MATH+ | 0.635 | 20.75 |
| 32 | RUSS J COORD CHEM+ | 0.605 | 12.52 |
| 33 | PALEONTOL J+ | 0.604 | 20.68 |
| 34 | J ANAL CHEM+ | 0.604 | 13.16 |
| 35 | COLLOID J+ | 0.588 | 5.04 |
| 36 | PLASMA PHYS REP+ | 0.584 | 14.17 |
| 37 | TECH PHYS LETT+ | 0.580 | 5.46 |
| 38 | HIGH TEMP+ | 0.578 | 5.44 |
| 39 | MOL BIOL+ | 0.570 | 2.03 |
| 40 | CRYSTALLOGR REP+ | 0.559 | 9.24 |
| 41 | REV ADV MATER SCI | 0.558 | 3.14 |
| 42 | COMBUST EXPLO SHOCK+ | 0.547 | 6.81 |
| 43 | PHYS ATOM NUCL+ | 0.539 | 15.40 |
| 44 | ACOUST PHYS+ | 0.534 | 22.44 |
| 45 | RUSS J ORG CHEM+ | 0.525 | 9.46 |
| 46 | OPT SPECTROSC+ | 0.505 | 13.25 |
| 47 | GEOCHEM INT+ | 0.502 | 11.87 |
| 48 | RUSS J GENET+ | 0.501 | 2.59 |
| 49 | RUSS J PLANT PHYSL+ | 0.500 | 4.80 |
| 50 | HIGH ENERG CHEM+ | 0.498 | 4.27 |

The ranking of the same journals according to K looks quite different.

**Table 9.** Ranking by K of Russian scientific journals in 2009

| Rank | Abbreviated Journal Title | Impact Factor | K 2009 |
|---|---|---|---|
| 1 | RUSS J MATH PHYS | 0.850 | 31.83 |
| 2 | STRATIGR GEO CORREL+ | 0.915 | 30.35 |
| 3 | THEOR PROBAB APPL+ | 0.827 | 24.18 |
| 4 | GEOTECTONICS+ | 1.000 | 23.64 |
| 5 | MOSC MATH J | 0.712 | 23.19 |



| 6 | ACOUST PHYS+ | 0.534 | 22.44 |
|---|---|---|---|
| 7 | REGUL CHAOTIC DYN | 0.725 | 21.26 |
| 8 | IZV MATH+ | 0.635 | 20.75 |
| 9 | PALEONTOL J+ | 0.604 | 20.68 |
| 10 | J MIN SCI+ | 0.352 | 20.00 |
| 11 | J RUSS LASER RES | 0.748 | 19.63 |
| 12 | PHYS MET METALLOGR+ | 0.477 | 18.42 |
| 13 | RUSS GEOL GEOPHYS+ | 1.000 | 17.42 |
| 14 | PHYS PART NUCLEI+ | 0.935 | 17.28 |
| 15 | PETROLOGY+ | 0.912 | 15.89 |
| 16 | ALGEBR LOG+ | 0.479 | 15.65 |
| 17 | SIBERIAN MATH J+ | 0.475 | 15.52 |
| 18 | RUSS J NUMER ANAL M | 0.485 | 15.49 |
| 19 | PHYS ATOM NUCL+ | 0.539 | 15.40 |
| 20 | PHYS-USP+ | 2.628 | 15.02 |
| 21 | PLASMA PHYS REP+ | 0.584 | 14.17 |
| 22 | RUSS CHEM REV+ | 2.073 | 14.17 |
| 23 | RUSS MATH SURV+ | 0.425 | 13.89 |
| 24 | POLYM SCI SER A+ | 0.688 | 13.62 |
| 25 | PROT MET+ | 0.347 | 13.40 |
| 26 | OPT SPECTROSC+ | 0.505 | 13.25 |
| 27 | J ANAL CHEM+ | 0.604 | 13.16 |
| 28 | RUSS J COORD CHEM+ | 0.605 | 12.52 |
| 29 | ASTRON LETT+ | 0.943 | 12.12 |
| 30 | PROBL INFORM TRANSM+ | 0.393 | 11.98 |
| 31 | GEOCHEM INT+ | 0.502 | 11.87 |
| 32 | DIFF EQUAT+ | 0.339 | 11.08 |
| 33 | MATH NOTES+ | 0.337 | 11.01 |
| 34 | GEOL ORE DEPOSIT+ | 0.331 | 10.47 |
| 35 | QUANTUM ELECTRON+ | 0.791 | 10.37 |
| 36 | RUSS J NONDESTRUCT+ | 0.195 | 10.37 |
| 37 | RUSS J MAR BIOL+ | 0.346 | 10.12 |
| 38 | ASTRON REP+ | 0.759 | 9.75 |
| 39 | INSTRUM EXP TECH+ | 0.331 | 9.54 |
| 40 | PMM-J APPL MATH MEC+ | 0.360 | 9.52 |
| 41 | JETP LETT+ | 1.662 | 9.50 |
| 42 | RUSS J ORG CHEM+ | 0.525 | 9.46 |
| 43 | FUNCT ANAL APPL+ | 0.289 | 9.41 |
| 44 | LASER PHYS | 0.676 | 9.37 |
| 45 | ASTROPHYS BULL | 0.723 | 9.29 |
| 46 | RUSS J ELECTROCHEM+ | 0.347 | 9.25 |
| 47 | CRYSTALLOGR REP+ | 0.559 | 9.24 |
| 48 | J VOLCANOL SEISMOL+ | 0.386 | 9.12 |
| 49 | IZV ATMOS OCEAN PHY+ | 0.371 | 9.09 |
| 50 | OCEANOLOGY+ | 0.307 | 8.95 |

It is interesting to compare the ranks of journals by the normalized impact factor K for K > 15 and by the impact factor Ip (Table 10below). The two well-known journals JETP LETT and J EXP THEOR PHYS do not appear in this table, because they have smaller values of K (9.50 and 5.62, respectively). Their ranks by K are 41 and 67 in the Russian national corpus.

**Table 10.** Ranks by K and by Ip of Russian scientific journals with K > 15

| Rank by K | Russian journals JCR:2009SE | Ip | K 2009 | Rank by Ip 2009 |
|---|---|---|---|---|
| 1 | RUSS J MATH PHYS | 0.850 | 31.83 | 13 |
| 2 | STRATIGR GEO CORREL+ | 0.915 | 30.35 | 10 |
| 3 | THEOR PROBAB APPL+ | 0.827 | 24.18 | 14 |
| 4 | GEOTECTONICS+ | 1.000 | 23.64 | 5.5 |
| 5 | MOSC MATH J | 0.712 | 23.19 | 23 |
| 6 | ACOUST PHYS+ | 0.534 | 22.44 | 5 |
| 7 | REGUL CHAOTIC DYN | 0.725 | 21.26 | 22 |
| 8 | IZV MATH+ | 0.635 | 20.75 | 31 |
| 9 | PALEONTOL J+ | 0.604 | 20.68 | 33.5 |
| 10 | J MIN SCI+ | 0.352 | 20.00 | 71 |
| 11 | J RUSS LASER RES | 0.748 | 19.63 | 19 |
| 12 | PHYS MET METALLOGR+ | 0.477 | 18.42 | 54 |
| 13 | RUSS GEOL GEOPHYS+ | 1.000 | 17.42 | 5.5 |
| 14 | PHYS PART NUCLEI+ | 0.935 | 17.28 | 9 |
| 15 | PETROLOGY+ | 0.912 | 15.89 | 11 |
| 16 | ALGEBR LOG+ | 0.479 | 15.65 | 53 |
| 17 | SIBERIAN MATH J+ | 0.475 | 15.52 | 55 |
| 18 | RUSS J NUMER ANAL M | 0.485 | 15.49 | 52 |
| 19 | PHYS ATOM NUCL+ | 0.539 | 15.40 | **43** |
| 20 | PHYS-USP+ | 2.628 | 15.02 | **1** |

Further, it is interesting to compare the bibliometric indicators (and ranks) off our Russian journals from the *Physics, Mathematical* (UR) category with the two Russian journals, J EXP THEOR PHYS+ and JETP LETT + from the *Physics, Multidisciplinary* (UI) category (Table 11).

**Table 11.** Bibliometric indicators for 6 Russian journals: 2008–2010

| Journal abbr | Category code | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|
| | | Ip | K | Ip | K | Ip | K |
| COMP MATH MATH PHYS+ | PN, UR | — | — | — | — | 0.380 | 12.88 |
| REGUL CHAOTIC DYN | PN, PU,UR | 0.568 | 12.94 | 0.725 | 21.26 | 0.529 | 15.93 |
| RUSS J MATH PHYS | UR | 0.944 | 28.09 | 0.850 | 31.83 | 1.131 | 46.73 |
| THEOR MATH PHYS+ | UR, UI | 0.721 | 11.52 | 0.796 | 7.90 | 0.748 | 13.50 |
| J EXP THEOR PHYS+ | UI | 0.892 | 9.74 | 0.871 | 4.98 | 0.946 | 10.92 |
| JETP LETT + | UI | 1.418 | 15.48 | 1.662 | 9.5 | 1.557 | 17.98 |



We see that in 2010 RJMP is in first place among six Russian journals in the physical fields. The journal JETP LETT is in second place in 2008 and 2010 by values K.

In Figure 8 below, we show the dynamics of the values of the normalized impact factor K for the same six Russian journals in the physical sciences.

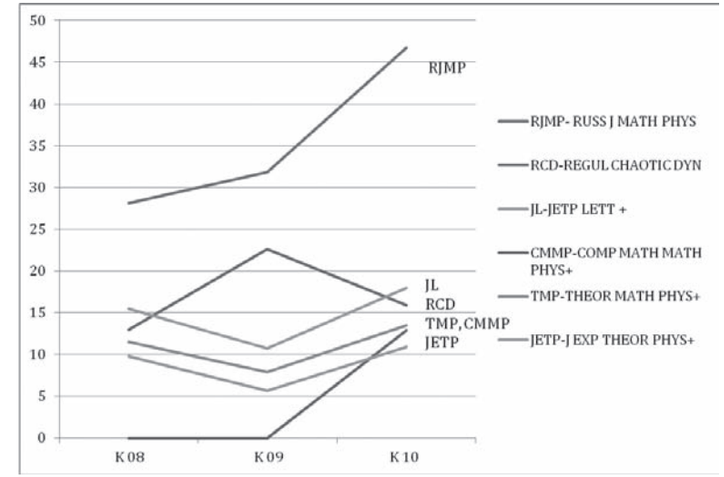


**Fig. 8.** Dynamics of the normalized impact factor K for six Russian physics journals

Thus Figures 3 and 8, together with Table 10, show that RJMP is in first place by normalized impact factor K not only among Russian journals in the physical and mathematical sciences, but also among all the Russian scientific journals appearing in the JCR databases in 2008-2010.

In conclusion of this section, it is interesting to compare, on the one hand, the ranks of five important physics journals indexed in the categories *Physics, Mathematical* (UR) and *Physics, Multidisciplinary* (UI) (by two bibliometric indicators: the normalized impact factor K and the impact factor Ip) in the entire Russian scientific corpus (123 journals) with, on the other hand, the ranks of those journals in the appropriate categories by the impact factor Ip from the JCR database for 2009 (Table 12).

**Table 12.** Bibliometric indicators for 6 Russian journals: 2009

| Abbr. journal title | K | Ip | Rank in Russian national corpus (123 journals) | | Rank in category UR (47 journals) | Rank in category UI (71 journals) |
|---|---|---|---|---|---|---|
| | | | by K | byIp | byIp | byIp |
| **RUSS J MATH PHYS** | 31.83 | 0.850 | 1 | **13** | **33** | **—** |
| REGUL CHAOTIC DYN | 22.60 | 0.725 | 7 | 20 | 37 | — |
| **JETP LETT +** | 9.50 | 1.662 | 41 | 3 | — | 24 |
| THEOR MATH PHYS+ | 7.90 | 0.796 | 53 | 15 | 34 | — |
| **J EXP THEOR PHYS+** | 5.62 | 0.871 | 67 | 12 | — | 40 |

## 9. The citations of V. I. Arnold

To conclude this study, the author would like to analyze the citations of the work of the famous Russian mathematician Vladimir Arnold, to whom this article is dedicated. We present the citation of V. I. Arnold in the period 1945-2011 below.

The JCR database Web of Science (ISI Web of Science: 1945–2011) includes 3248 cites to Arnold's publications in a total of 2012 records (documents). We analyze cites by (1) categories, (2) countries, and (3) authors.

(1) References to Arnold appear in 29 Web of Science categories, but more than 50 % of them are in the following 9 categories:

MATHEMATICS (562)
MATHEMATICS APPLIED (468)
PHYSICS, MATHEMATICAL (364)
PHYSICS MULTIDISCIPLINARY (312)
MECHANICS (245)
PHYSICS FLUIDS PLASMAS (130)
MULTIDISCIPLINARY SCIENCES (95)
MATHEMATICS INTERDISCIPLINARY APPLICATIONS (83)
ASTRONOMY ASTROPHYSICS (74)

(2)Almost one fourth of the references to Arnold are from the USA (507), Russia holds second place with 290 cites, with France (241), England (156), USSR (104), Germany (102), Canada (90), Italy (85), China (71), Israel (59) and others. Total statistics by countries shows that references to Arnold's papers were done by authors from 57 countries.

(3) The 2012 cites to Arnold belong to 742 authors, 29 of them cited Arnold in more than seven publications:

| Authors | Record-Count | % of 2012 | Authors | Record-Count | % of 2012 |
|---|---|---|---|---|---|
| MARSDEN JE | 28 | 1.392 | GLASS L | 8 | 0.398 |
| HOLM DD | 24 | 1.193 | GUCKENHEIMER J | 8 | 0.398 |
| SHEPHERD TG | 22 | 1.093 | MAHALOV A | 8 | 0.398 |
| ARNOLD VI | 18 | 0.895 | NICOLAENKO B | 8 | 0.398 |
| MOSEKILDE E | 15 | 0.746 | SAGDEEV RZ | 8 | 0.398 |
| GRAMMATICOS B | 13 | 0.646 | SPERL M | 8 | 0.398 |
| RAMANI A | 13 | 0.646 | VLADIMIROV VA | 8 | 0.398 |
| RATIU TS | 12 | 0.596 | BRENIER Y | 7 | 0.348 |
| GOTZE W | 11 | 0.547 | GAETA G | 7 | 0.348 |
| IEEE | 11 | 0.547 | KARPENKOV ON | 7 | 0.348 |
| JANECZKO S | 11 | 0.547 | KHESIN B | 7 | 0.348 |
| CHERNIKOV AA | 10 | 0.497 | KOZLOV VV | 7 | 0.348 |
| CHERNIKOV AA | 10 | 0.497 | KRAUSKOPF B | 7 | 0.348 |
| MU M | 10 | 0.497 | MARCHIORO C | 7 | 0.348 |
| CHIRIKOV BV | 9 | 0.447 | OSINGA HM | 7 | 0.348 |
| MARMI S | 9 | 0.447 | PUTA M | 7 | 0.348 |
| ZASLAVSKY GM | 9 | 0.447 | RATIU T | 7 | 0.348 |
| | | | SOSNOVTSEVA OV | 7 | 0.348 |



## Conclusion

1. The bibliometric analysis of scientific journals, based on the JCR databases, shows that the impact factor of fields of science (Ig) is growing in science as a whole. The growth of the number of citations is due both to the progress of science proper and of the means of communication facilitating access to information.

2. The normalized impact factor (K) is a tool for the comparison of journals across fields of knowledge, and it is very important in assessing national contributions to world science.

3. The traditional impact factor (Ip) favors such disciplines as biology and medicine and can hardly be used in reference to fields with lower level of citedness (such as mathematics or technology). The introductions of the normalized impact factor K will help remedy that injustice.

4. The bibliometric analysis of Russian mathematical journals shows that they occupy only a modest place in the world list of 609 mathematical journals (see Tables 3 and 4). However, within the national Russian corpus of scientific journals, they fare much better. Measured by the normalized impact factor, eight mathematical journals (RJMP, THEORPROBABAPPL+, MOSCMATHJ, REGULCHAOTICDYN, ALGEBRLOG+, SIBERIANMATHJ+, RUSSJNUMERANALM) appear among the twenty leaders of the list of 140 journals. In 2009 and 2010, the list is headed by the Russian Journal of Mathematical Physics, published in English by MAIKNAUKA/ INTERPERIODICA/SPRINGER.

***Acknowledgements***

The author is grateful to A. B. Sossinsky for translating the author's poor English into clear idiomatic American English. This study was supported by the RFBR grant № 10-06-0018a.

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# Creating Linkages: Government Policy to Stimulate R&D through University-Industry Cooperation in Russia

The article analyzes new government measures aimed at the creation of linkages between universities and companies in Russia to strengthen R&D and make them more effective in terms of practical applications. Three measures are assessed — programs of innovation development of large government-controlled companies, technology platforms, and cooperative R&D projects. It is shown that all measures are important and interconnected though there are some flaws in their implementation. At the same time application of these measures caused a number of positive side effects for Russian R&D complex.

***Keywords:*** R&D, universities, companies, financing, workforce, technology platforms, programs of innovative development, joint R&D projects

## State of R&D in Russia

The R&D complex inherited to a large extent Soviet traditions and organization. It is still highly hierarchical, and centralized. The federal government dominates both in terms of financing and control over organizations involved in R&D. Federal budget is the major source of support for R&D in Russia and the share of federal budget among the sources of support is increasing while business plays an insufficient role in financing R&D. Moreover, government in a way substitutes private funds creating in this way disincentives for business. All these characteristics are especially noticeable from international perspective (tables 1 and 2).



Table 1

Gross Domestic Expenditures on R&D Financed by Government and Industry, in % of Total Gross Expenditure on R&D

| Country | Business enterprises | | Government | |
|---|---|---|---|---|
| | 2005 | 2010 | 2005 | 2010 |
| United States (1) | 64.3 | 61.8 | 30.2 | 27.3 |
| Japan (2) | 76.1 | 78.2 | 16.8 | 15.6 |
| Germany | 67.6 | 66.1 | 28.4 | 29.7 |
| France | 51.9 | 52.4 | 38.6 | 38.6 |
| United Kingdom | 42.1 | 44.5 | 32.7 | 32.6 |
| European Area (17 countries) | 56.1 | 55.7 | 35.4 | 35.4 |
| Russia | 22.4 | 18.3 | 60.1 | 68.8 |

(1) Data for 2009
(2) Data for 2008
Sources: (EUROSTAT, 2011); (Science and Engineering Indicators, 2012: 254); (Nauka, technologii i innovatsii Rossii: 2009: 25); (Nauka, technologii i innovatsii Rossii: 2011: 31)

As it may be seen from the data presented in table 1, the share of business in financing R&D in most of the developed countries is high — over 50 % average — and was growing over years. In Russia, in opposite, the share of federal government is excessively high and has grown by 9 % for the last 5-year period, reaching almost 70 % of the total intramural expenditures on R&D.

Government participation in financing R&D in the business sector in Russia is also unprecedented — it is close to 60 % while the average for OECD countries is about 7 % (table 2).

Table 2

Percentage of Business Enterprise Expenditure on R&D Financed by Government

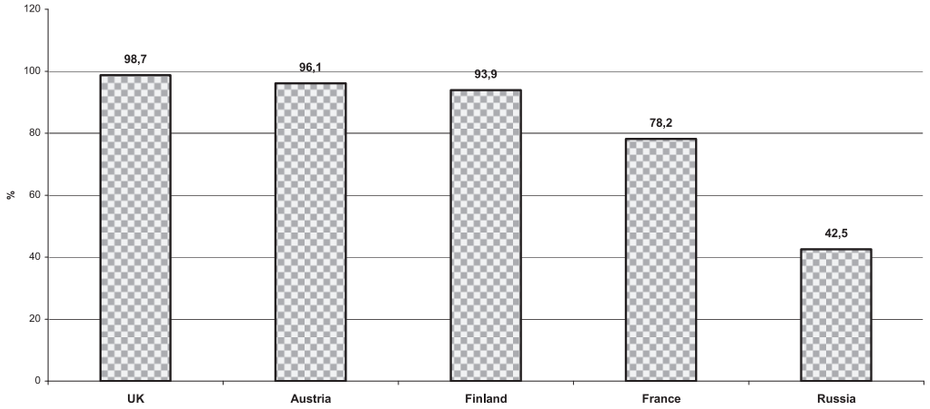
| Country | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| United States | 9.7 | 9.8 | 9.9 | 8.9 | 14.0 |
| Japan | 1.2 | 1.0 | 1.1 | 0.9 | — |
| Germany | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| France | 10.1 | 11.3 | 9.8 | 11.4 | — |
| United Kingdom | 8.3 | 7.6 | 6.8 | 6.6 | 6.6 |
| Total OECD countries | 6.8 | 6.8 | 6.8 | 6.5 | — |
| Russia | 53.6 | 52.0 | 55.3 | 56.0 | 57.4 |

Sources: (OECD,2010: 59); (Science and Engineering Indicators, 2012: 238)

Another specific feature of the Russian R&D complex is low and decreasing support for R&D from abroad. The share of financing from abroad in the total expenditures on R&D is 8.4 % for OECD countries in average (data for 2009), with variations from 3.8 % in Germany to 16.6 % in UK (EUROSTAT, 2011). In Russia it is 3.5 % (data for 2010) (Nauka, technologii i innovatsii Rossii: 2011: 31). This indicates that foreign financing in the form

of charitable aid has decreased for Russia dramatically — at the end of 90-s foreign support reached almost 17 % and the main foreign source were charitable foundations and technical assistance programs (Graham, Dezhina, 2008: 113). At the same time Russian science did not become attractive for foreign investments that may be directed for applied research and developments. This is confirmed by a small share of financing for R&D provided by foreign business, as compared to developed countries of the world (graph 1).

Graph 1. R&D Expenditures Funded from Abroad by Foreign Business Enterprises, % in Total Expenditures from Abroad



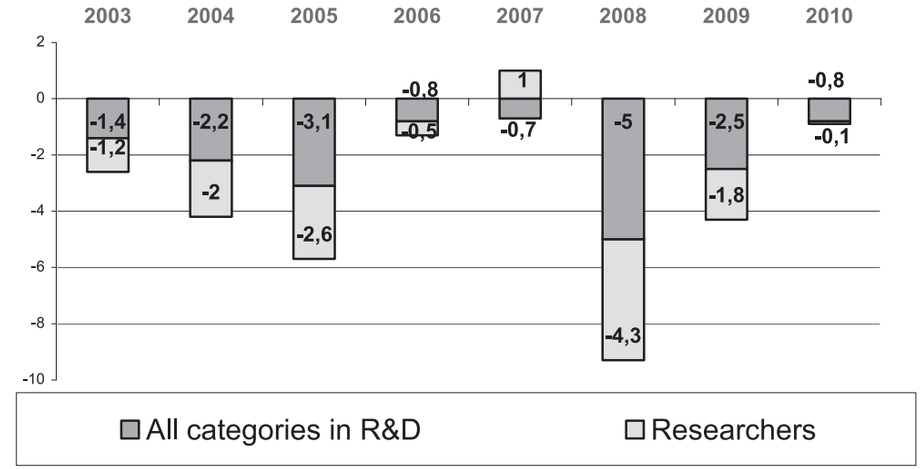

Sources: (OECD, 2011), (Nauka, technologii i innovatsii Rossii, 2011: 32)

Not very comfortable conditions for R&D in Russia as well as growing problems related to the scientific workforce preclude both domestic and foreign business from investments in R&D. By volumes of support for R&D and by number of personnel Russia is not any more among the world leaders, as it was in the Soviet Union. Russia spends on R&D just 1.16% of GDP (data for 2010) (Nauka, technologii i innovatsii Rossii, 2011: 9) while OECD countries — 2% on average (data for 2010), United States — 2.79% (data for 2008) and Japan — 3.45 % (data for 2008) (EUROSTAT, 2011). By the number of researchers Russia (369 thousand in 2010 (Nauka, technologii i innovatsii Rossii, 2011: 9)) is now ranked fourth in the world after China (1592 thousand), the United States (1413 thousand) and Japan (657 thousand) (OECD, 2010: 18). There was continuing outflow of researchers during the post-Soviet years; in 2007 there was a break in the trend[3] when a slight increase in the number of researchers has occurred (graph 2).

[3] There is no solid explanation why the growth in 2007 has happened. One of the reasons explaining the situation may be in the fact that government financing was growing since 2005 and there was a clear plan for development for science sphere until the year 2010 so R&D complex became more attractive in terms of stability and predictability of income. But in 2008 — when crisis started — it became clear that financial situation may worsen fast, and scientists started to leave — in particular, to higher educational institutes because teaching is more stable then contracts- and grants-based research.



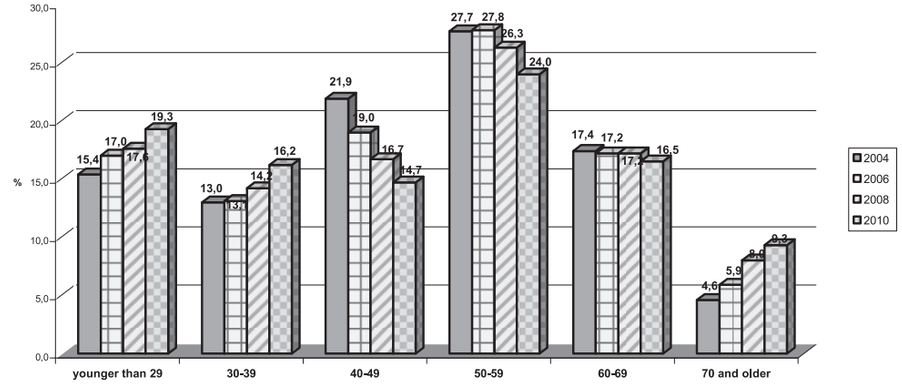
Graph 2. Changes in R&D Personnel, % to the Previous Year




Sources: (Nauka Rossii v Tsifrakh, 2010: 46); (Nauka, technologii i innovatsii Rossii, 2011: 9)

The economic crisis has lead to further decline in terms of number of R&D personnel and since the decrease over the years was spontaneous and not regulated by the government, the age structure of researchers was worsening. The latest data for 2010 confirmed continuation of a long lasting trend (graph 3): young researchers come and go, middle-aged group continues to be small, cohort of older generations of scientists is growing and the time is approaching when Russia will face a real crisis: there will be not enough teachers to educate the next generations of scholars.

Graph 3. Changes in the Age Structure of R&D Personnel in Russia




Sources: (Nauka, technologii i innovatsii Rossii, 2007: 17); (Nauka, technologii i innovatsii Rossii, 2011: 19)

Another hamper for development is the unreformed organizational structure of the Russian R&D complex. Academies and universities continue to perform their functions that were assigned to them in Soviet times. Universities are mainly teaching institutes with minor and not very productive involvement in research; Academies continue to play major role in fundamental research and are underestimated as teaching establishments.

The Russian Academy of Sciences (RAS) is the largest and most prominent research organisation in the country, which consists of 431 research institutes (Nauka RAN, 2010: 8)[4] and the number of institutes under the auspices of the RAS is rather stable, fluctuating between 448 in 2006 and 430 in 2009. In addition to fundamental research Academies also conduct some applied research and about 1/3rd of RAS researchers are involved in teaching at universities.

Universities occupy a modest place in the Russian R&D system. Even though over 500 higher educational institutes are involved in R&D (Nauka, technologii i innovatsii Rossii, 2011: 10)[5], financial and human resources in the higher education R&D sector amount to about 8.4 % and 10.5 % respectively of the national total (Nauka, technologii i innovatsii Rossii, 2011: 9; 46)[6]. Meanwhile this is an increase of 1.7 % both for financing and number of personnel in comparison with 2008. This change reflects new government policy started in mid-2000-s aimed to redirect financing from the Academy and some other institutes to universities through a number of policy initiatives, some of which will be discussed below. Overall Russian universities are almost not present in international rankings of the top universities, mainly because of a relatively weak research performance and lack of presence of international staff[7].

Finally, so-called "branch institutes" that in the Soviet Union were serving needs of various industries were mostly destroyed due to privatization that was taking place in the first post-Soviet decade. At the present time they started to revive in forms of corporate R&D divisions in private companies and in large government-controlled companies. Some continue to exist as government-owned R&D institutes, especially if they have large facilities and unique equipment.

Business not only provides modest financing for R&D but in a broader sense a very small percentage of firms is involved in any types of innovative activity. According to Rosstat data, the share of industrial enterprises implementing technological innovations was below 10 % for the last 5 years (Indikatory innovatsionnoy deyatelnosti, 2011: 9). Among those companies, which are involved in any type of innovative activity, only about 1/3rd invest in R&D — a decrease in comparison with the end of 90-s when the share of such enterprises was about 50 % (Indikatory innovatsionnoy deyatelnosti, 2011: 16).

Only in 2011 were the first signs of interest to innovation activity registered among large industrial enterprises. Most noticeable was the fact that investments in R&D became more in focus of companies' attention. This may be explained by the fact that purchase of technologies abroad, often — second-hand — the most widely used approach to modernization — was played out. This is especially true for the large companies competing at international markets. According to a survey conducted by PricewaterhouseCoopers, 58 % of Russian companies that sell their products in the internal market have certain

[4] Data for 2010.

[5] Data for 2007–2010.

[6] Data for 2010.

[7] See, for example, www.topuniversities.com



innovative technologies. For companies competing in international markets this figure is 85 % (Saraev, Medovnikov, Oganesyan, 2011: 22). Then, interviews conducted in 2011 by the Institute of Management among 22 large Russian companies (Association of Managers, 2011: 30–31) have revealed that none of the surveyed companies decreased their expenditures on R&D. Moreover, they have developed some interest to the R&D conducted by Russian research institutes.

As an overall result, the efficiency of the R&D complex in Russia is the lowest in the group of fast growing economies — BRIC countries: thus, average citation of one Russian publication is 4.8 times while of Indian — 5.8, Chinese — 6.1 and Brazilian — 6.3[8] (Nauka, technologii i innovatsii Rossii, 2011: 79). The field structure of cited publications shows that the strongest areas of research in Russian science continue to be those, which were traditionally strong in the Soviet Union — physics, space research, Earth sciences, chemistry, and mathematics. However, in each discipline a decrease in the share of world total publications can be observed. This means that science in other countries is developing in a more productive way than in Russia.

The international standing of Russia in terms of patenting is far behind developed countries of the world. Thus, the share of Russia in triadic patent families (triadic patent family means simultaneous patenting of the same invention in USA, Europe and Japan) is 0.14% while for the US it is 30 %, EU countries (27 countries) — 30%, Germany — 12 %, UK — 3.4 %, Japan — 28 %, China — 1 % (OECD, 2010: 89)[9].

The Russian government, understanding the role business plays in modern R&D complexes, in recent years initiated a number of measures aimed to increase innovation activity in the business enterprise sector, including a set of actions to push companies to outsource R&D in universities. The latter pursues three goals: 1) to strengthen linkages in innovation system and improve research in universities; 2) make universities to serve more industrial needs and in this way partially to substitute for the deteriorated "branch sector" of science, 3) encourage business to develop longer-term horizons for their R&D policy.

In 2010–2011 the government initiated three most important "linkages-oriented" measures, namely:

- Programs of innovation development at large government-controlled companies — total 47 companies have developed such programs;
- Establishment of technology platforms — total 28 platforms are created[10] in which 200 universities and 300 research institutes take part[11];
- Cooperation in R&D between universities and companies aimed to lead to new high-tech production; the measure is implemented according to government Decree № 218 from April 9, 2010[12].

Below each of these government actions is analyzed in more detail.

[8] Data for 2001–2011 from the database "Essential Science Indicators".

[9] Data for 2008.

[10] From 47 companies that developed innovative programs, 37 take part in technology platforms, and 9 are their coordinators (Government Commission on High Technologies and Innovations, 2012).

[11] Data for January 1, 2012.

[12] Government Decree № 218 as of April 9, 2010 "On the government measures to support the development of cooperation between Russian higher educational institutes and organizations that implement complex projects aimed to creation of high-tech production".

## Large Government-Controlled Companies: Programs of Innovation Development

In 2010 the government decided to encourage R&D investments of large government-controlled companies by "pushing" them to innovate. Companies were obligated to develop long-term innovative programs. One of the obligatory requirements for the companies is cooperation with universities and partial outsourcing R&D to them that is necessary for the companies. The idea is that partial outsourcing will help to overcome internal monopolistic positions of R&D divisions at companies and raise the effectiveness of R&D spending in business-sector. Simultaneously this cooperation should help to increase the quality of research in universities.

By 2011, 47 large companies have developed such programs. According to the data from these programs, the volume of R&D to be outsourced to universities will be gradually increasing (table 3). Companies cannot know their future in such a detail but this is a reflection of Russian style of government order. Government asked companies to forecast their achievements within next five years, and companies, like in planned economy, made their predictions.

Table 3

Programs of Innovation Development of Large Government-Controlled Companies: Growing Outsourcing of R&D

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Total financing of R&D according to programs of innovative development, billion RUR | 82.9 | 227.6 | 291.9 | 344.1 | 330.7 | 304.6 |
| R&D to be outsourced to universities, billion RUR | 2.9 | 11.5 | 16.5 | 20.2 | 21.0 | 22.8 |
| Share of financing for R&D to be outsourced to universities, % | 3.5 | 5.0 | 5.7 | 5.9 | 6.3 | 7.5 |

Source: Data from the Ministry of Education and Science of the Russian Federation

This approach may give a stimulus for companies to invest more in R&D. However there are a number of problems that will be obstacles to successful implementation of this approach. The financial forecasts presented by companies in their programs heavily rely on budget support for R&D because at the present time 60 % of expenditures on R&D at these companies are financed by the government (Government Commission on High Technologies and Innovations, 2012). Then, programs are not well coordinated with companies' long-term strategies (for those companies that have them), as well as with financial plans that are usually developed with 1-year horizons.

The problems related to cooperation with universities are associated with low quality of R&D in most universities, underdeveloped managerial skills in the government R&D sector, and the low ability of universities to follow requirements that companies set for R&D results. This was clearly revealed through the survey conducted by the Association of Managers as well as through the survey conducted by the author aimed to clarify the developments, and indirect effects that have occurred in course of cooperation between universities and companies. Companies obligated to outsource R&D faced the problem that they cannot find university teams that will be able to fulfill all necessary requirements for R&D. At the same time, since companies were instructed to cooperate with universities, 96 % of them included collaboration to their programs of innovation development. More likely this will be mostly outsourcing and not cooperative projects because only 17 % of companies plan to use jointly with universities research and experimental equipment located either at universities or at companies.



Programs of innovative development will be carefully monitored by the government. Monitoring will be conducted every quarter as well as annually, using a large number of indicators. Monitoring is based mostly on quantitative assessment of expenditures and resources rather than on evaluation of results. Then, each government agency involved in this initiative is interested in those aspects of companies' performance that are in line with their agendas. Thus, for the Ministry of education and science it is very important to see how cooperation between companies and universities is developing; for the Ministry of economic development the most important is compliance of companies' programs with large government programs of industrial development and modernization. With such an approach there is a broad range of indicators and this already has lead to the companies' dissatisfaction with the government policy. Indeed, the methodology of data collection is so complicated that it requires companies hiring special staff to deal with reporting to the ministries. Therefore this may lead to increased overhead, and to overall profanation. At the same time it is very difficult to check the adequacy of all data that will be supplied by companies. It could be more effective to cut a number of indicators in favor of better quality monitoring and to include not only quantitative but qualitative indicators aimed to measure the outcomes of these programs.

This initiative may be stimulating for companies that will find appropriate universities-partners and for those universities that are ready to learn new organizational and managerial approaches to conducting R&D and that have resources for that. Overall administrative "force" for innovations though is a questionable mechanism to encourage productive spending on R&D, and not just increase its volume.

## New Mechanism to Establish Linkages: Technology Platforms

The initiative to create technology platforms started in 2010. The first idea was to create organizational mechanisms for negotiations of interests of various stakeholders in development of new innovative projects and products. Then, the idea slightly shifted to a concept according to which technology platforms should produce new technologies that will in turn encourage development of various economic sectors. The final goal of the creation of technology platforms is to raise high-tech production and stimulate growth of high-tech companies in Russia. The mechanism of negotiations based on technology platforms is not a Russian invention. The concept was largely borrowed from the European Union experience.

In August 2010 the government issued the rules for creation of technology platforms[13]. The definition of technology platforms was formulated in the following way: these are "communication instrument directed towards activation of efforts to create perspective commercially valued technologies, new products (services), towards attraction of additional resources for R&D based on participation of all interested parties (business, science, state,

[13] The procedures to create technological platforms were approved by the Government Commission on high technologies and innovations on August 3, 2010.

civil society), improvement of legal basis in the area of scientific-technological, innovation development". Two ministries — the Ministry of Economic Development and the Ministry of Education and Science — started to collect suggestions on technology platforms from groups that included enterprises, research institutes, universities, associations of professionals and other interested parties. More than 200 suggestions were collected from which 28 technology platforms were selected.

The mechanism of technology platforms was quite effective in European Union, and ideally it should be useful for Russia as well because technology platforms may open new opportunities for its participants due to:

- Access to new resources for R&D;
- Participation in priority setting for industrial development;
- Lobbying of corporate interests in development of technical regulations and standards;
- Optimization of business planning due to the fact that among participants of technology platforms there are both producers and consumers of new technologies;
- Possibility to use wider approach called "open innovation"[14];
- Development of international cooperation;
- Solving workforce problems for science and business sector.

However the Russian way of development technology of platforms from the very beginning was slightly different from the EU path. The European approach consists of three steps. At the first step priority directions for technological development are selected by platforms. At the second step technology platforms develop roadmaps. At the third step there should be the start of implementation of R&D projects initiated by technology platforms. Financing for these projects may come from various sources.

In Russia at the first step platforms had to fit themselves to already chosen federal-level priorities. Moreover, at the present time in Russia there are two lists of overlapping priorities for scientific and technological development. The first list includes 8 priority directions and 27 critical technologies clarifying these priority directions[15]. In parallel there is another list — of 5 directions of "technological breakthrough" that were defined by the President in 2009[16], and according to which, for example, Skolkovo "clusters" were formed.

Therefore the choice of thematic areas of technology platforms was conducted in line with already existing lists of priorities. However, the final list of thematic areas for 28 technology platforms does not fully duplicate government priorities. In the EU priorities that were identified by technology platforms then became part of thematic areas within the EU Framework program; in Russia, as one may see, technology platforms do not really open new avenues for development. Their role is more in bringing various stakeholders together.

As a result, R&D projects of technology platforms in their subject areas not fully fit to the thematic areas of the federal goal-oriented programs that may serve as a source of support for R&D projects selected within platforms. At the present time federal goal-oriented programs

[14] Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology (Chesbrough, 2003: xxiv).

[15] The list of priorities was approved by Presidential order № 899 from July 7, 2011 "About approval of priority directions for the development of science, technologies and techniques in the Russian Federation and the list of critical technologies of the Russian Federation".

[16] These are energy efficiency and energy saving, nuclear technologies, space technologies, medical technologies, strategic information technologies.



are structured according to federally approved lists of priorities. All that means that platforms represent the 3rd list of priorities but there is no clear mechanism yet of their implementation.

The second stage — development of roadmaps — in the Russian version is attached to the process of development of innovative programs for large government-controlled companies — the initiatives that were discussed earlier in the article. The 47 large companies who develop their innovation programs are obligated to take part in technology platforms[17].

Another government assignment is obligatory participation of universities in platforms. At the present time some companies see this requirement as an extra pressure while, on the other hand, universities were quite enthusiastic participants in the process of formation of technology platforms. Recent survey of 193 university employees has shown that creation of technology platforms is ranked third among the types of activities that universities would like to pursue jointly with companies (Klimov, Frumin: 2011). It is even more popular then training specialists for the companies' needs.

The third stage is realization of R&D projects developed by technology platforms. This stage is only starting in Russia, and the projects receive support mainly through the Russian Fund for Technological Development (RFTR), which, after its reconfiguration in 2011, was reoriented by the government towards support of applied-oriented projects initiated within technology platforms. However the RFTR budget is rather small and the Fund is able to support only a selected number of R&D projects. Other sources of financing that were discussed in policy documents — such as RUSNANO, federal programs, programs of fundamental research of government Academies, financial resources of corporations and private companies — are not used yet in the interests of technology platforms. More likely some support will be provided through federal goal-oriented programs but in this case R&D projects should thematically fit to the programs' priorities.

In general two scenarios for the development of R&D projects initiated by technology platforms may be foreseen.

According to the first scenario technology platforms will get a certain official status that will allow them to have priority access to government financial resources. Such statuses are a regular practice in Russian science and innovation policy. The examples are Federal research centers — status awarded to R&D institutes that have large and expensive facilities and unique equipment; status of federal universities — awarded to higher educational institutions that were created after merging of several previously existed universities and aimed for the regional development, etc.

In the second scenario technology platforms will combine status and special line of financing that they will receive for R&D projects. This may happen within new government Program of science and technology till the year 2020, which is under development at the present time.

## Cooperation in R&D Between Companies and Universities

In 2010 the Russian government initiated one more new measure based on cooperation between companies and universities. It is outlined in the government Decree № 218 "On the government measures to support the development of cooperation between Russian higher educational institutes and organizations that implement complex projects aimed to

[17] Obligation is reflected in the Presidential assignment to the Commission on modernization and technological development of the Russian economy (№ пр-22 from January 4, 2010).

creation of high-tech production". This decree defines mechanism of competition-based R&D financing of industrial enterprises in order to implement complex projects aimed at organization of high-tech production. R&D projects should be conducted in cooperation with higher educational institutes. The goals of this initiative were defined by the Ministry of education and science in the following way:

1) Development of cooperation between Russian higher educational institutes and companies;

2) Strengthening research and educational components in Russian universities;

3) Stimulating industrial companies to utilize the potential of universities for the development of research-based production and innovation activity in Russian economy as a whole.

The new measure combines several components. First, it is competition-based — the winner is selected on the basis of open competition. Second, the support is provided to commercially valuable projects implementation of which should lead to high-tech production. Third, partnership is encouraged through support of joint project conducted by a company together with a university. The government money goes to the company that uses it to finance R&D project implemented by university for the company needs.

Financing of R&D provided by the government is for a period from 1 to 3 years and is up to 100 million RUR per project per year. Simultaneously the company should 100 % cofinance the project; from the company's money at least 20 % company should spend also for R&D. Thus, from the total amount of money for the project more than half should be spent for R&D. There are also quite strict requirements concerning monitoring of these projects — companies should submit to the government reports about the high-tech production during 5 years after the completion of the project.

The total number of projects that were selected in 2010 was 112 and the amount of financing that will be directed to their support during 2010–2012 is about 16.3 billion RUR.

In 2011 a selected number of R&D projects were monitored, and the author took part in interviews with project participants both from the side of companies and universities, and interpretation of their results. It is early to assess direct results of this imitative but it is possible already to identify some problems as well as positive not expected outcomes.

All problems that were identified in the course of projects implementation may be divided into internal and external ones. Internal problems are related to the interaction between companies and universities in their joint work. External problems are connected with economic and legal rules that are applicable for such cooperation.

The most common internal problem is related to unawareness of universities about real demand in the innovation area. Representatives of companies were expressing opinions that university researchers are "too academic" in their studies, they do not know real needs of companies as well as procedures that should be implemented to conduct applied projects properly. The complaint from side of companies also was that universities do not get used to accountability for their research results.

A logical explanation of this situation is in the fact that teaching loads are very high so university professors do not really have time for research. There is only a small number of universities in Russia which enjoy privileged conditions for teaching and only they have real potential to strengthen their research potential.

University representatives were quite objective in assessing their research capabilities. They admitted that applied research and developments need additional skills that were lost during the post-Soviet years or were nonexistent. The middle-aged generation of professors is very small, as in all Russian R&D complexes and thus human potential for research is



weak. Universities also claim the absence of certain specialists in their research teams — such as designers and technologists. Therefore the major problem that universities face today lies in the workforce area, not just in shortage of financial resources or infrastructure. Unfortunately this is the type of problem that cannot be solved easily. University administrators see this collaboration with companies as a possible tool to identify the best researchers, create productive research groups and thus move research forward.

Companies in certain instances have found ways to solve workforce problem in order to implement the project. One of the approaches was to look for necessary specialists in various universities, not just in the university that is their official partner. In this way companies could also learn more about educational programs that exist in universities and in some cases — to suggest improvements in the educational process to link it closer to the modern needs of research in business sector.

External problem were mostly related to different legal requirements, such as federal procurement regulations, reporting procedures to the ministry, bureaucracy. The biggest number of complaints was associated with excessive paperwork that is needed to report intermediate results. If universities already got used to this situation, for many companies this was one of unpleasant discoveries of dealing with federal money. However many companies took a quite rational approach and were able to overcome this obstacle by hiring special staff that deals with reporting and paperwork for the government.

Analysis of interviews also allowed identifying several major side effects of this measure. First, this is strengthening of university orientation towards solving practical tasks in the interests of business. Many university representatives were stating that an important factor for them was real interest from the side of companies in the research results that may be produced by universities. Indeed, work under government orders often leads to a paper report without any further practical applications. This is often a disincentive for university researchers.

A second side effect is in formalization of relationships among companies and universities. This means a shift from contacts at the level of selected professors or researchers to project groups or laboratories. In some instances joint company-university research groups were formed, including representatives from small innovative companies that were established by universities. This helped to solve the workforce problem and to develop horizontal linkages.

Third is integration of research and education. Cooperation in some cases resulted in development of new educational courses or supplementary courses for university students. Also, such cooperation is a better way to further employment of graduates. Students have a chance to take part in joint projects, learn more about the company and its operations, and even start part-time work in a company. For universities such developments are positive because graduates take jobs according to their specialization.

Fourth, there was some process of mutual adjustment and many teams overcame it successfully and even found supplementary competences. Therefore many respondents were saying that they plan to continue their collaboration in research. Some universities see a potential for future collaboration in further development of the project. For example, companies may have new needs both in research and new specialists-graduates in the course of the development of their high-tech manufacturing.

In conclusion it should be said that most of interviewed partners assess the new instrument positively, underlying that joint work with practical outcomes is much more interesting and satisfactory then R&D projects supported through the federal tender procedures. Universities could discover their major shortages both in personnel and management of research, and companies — to learn more about potential and culture of university R&D.

## Conclusions

The analysis of the government policy towards creation of linkages between companies and universities allows several summarizing conclusions.

1. All newly initiated measures are important, each in its own way, to develop linkages in R&D area. They are to a certain extent complimentary and interconnected, and this is a positive approach. It is important from the side of the government not to expect immediate results from implementation of these measures and to conduct them on a longer-term because the results usually may be seen within 5–7 years. Many previous government initiatives have led to insignificant results because they were supported briefly, up to 3 years and then new initiatives started. This chaotic policy change is one of the reasons for low outcomes.

2. One of the most crucial factors in innovation area is increasingly people. Brain drain, aging in science and educational systems leads to gradual deterioration of research and innovation potential. There is no a single measure to resolve this situation. One of many measures that should be undertaken is investing in various educational, training courses and programs, including those ones that will be developed together with business. Implementation of new measures discussed in the article may help to reveal areas that need primary attention.

3. Borrowing of foreign experience was not very successful so far because in most cases it could not be combined with existing economic conditions and legal requirements. Technology platforms set a clear example that strictly following the European model is not possible so there should be found a "Russian way" to utilize mechanism of technology platforms as an instrument to link universities and companies closer together.

4. Monitoring and evaluation continue to be crucial factors to the successful implementation of the initiatives because it may help to make timely necessary corrections. However monitoring should not create too much pressure on companies and universities and thus should not be conducted too often and accompanied by the requirement to collect excessive amounts of data.

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# МЕЖДУНАРОДНАЯ МОБИЛЬНОСТЬ: анализ адаптационных следствий


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## Integration of Biomedical Scientists from the Former Soviet Union in North America: an inside outlook


We have examined professional integration of those biomedical scientists from the former Soviet Union who entered the United States and Canada in the 1990's with temporary visas to conduct research in academic and government research centers. We looked at the retention and promotion of the scientist in academia, transfer to other occupations, migration to other countries, and return home after landing in North America. About two thirds (68 %) of Russian speaking scientists did not change their occupation and continued their employment in academic or government institutions of the host countries. Less than 10 % of researchers left to biomedical companies or moved to Europe or Australia. Some individuals with recent medical diplomas obtained licenses and went to clinical practice (6 % of total). A small fraction, about 3 %, made teaching their primary occupation. Finally, 7 % of researchers returned home. Our study provides a historical outlook that sheds light on the fate of scientists who departed from Russia and other post-soviet countries.



***Keywords:*** Integration, Russian Biomedical Researchers, Employment Based Mobility, United States, Postdoctoral Experience, Academic Career, Foreign-Born Faculty, Diaspora




### Introduction

In the 1990's, many scientists educated and trained in the Soviet Union found opportunities to continue research abroad. Numerous experts from Russia and other countries of the Former Soviet Union (FSU) addressed this phenomenon as "Brain Drain" (Asheulova, 2010; Dezhina, 2005; Kouznetsova, 1996; Suleimanov, 2010; Ушкалов и Малаха, 2000). Some scholars who study migration of scientists include this process or similar processes in other countries in a broader context as a part of "Brain Circulation" or "Brain Exchange" (Canibano et al., 2011; Pellegrino, 2001). Various aspects of Brain Drain such as the scale of migration, its geographical distribution, driving forces and its socioeconomic impact on the post-soviet countries received substantial attention. Both negative and positive effects have been discussed (Jimenez at al., 2010; Regets, 2007). On the other hand, studies of integration of FSU scientists in the research communities of foreign countries as a logical outcome of Brain Drain seem to be rare and sketchy. Integration has been defined previously as the process of gradual inclusion of newcomers in a host society with preservation of their cultural core while developing additional adaptive facets of identity, skills, networks, etc. (Remennick, 2003a).

Why is the study of integration of scientists important? In our opinion, a better understanding of this process can be helpful in broadening competences of government officials and policy makers responsible for direction and development of the national scientific resources including human capital. Particularly, it can be helpful in establishing a productive communication and cooperation with Russian speaking scientific diaspora. Contacts with scientists abroad have always been seen as a potential advantage by strategically thinking researchers and administrators. Since early 1990's exchange with foreign-based colleagues underwent a substantial transformation. A report about the conference "Scientific Diaspora and the Future of Russian Science' suggests that there is a significant interest among some representatives of the Russian scientific community in developing mutually beneficial relationships with constantly growing Russian speaking network of scientists abroad (Dezhina, 2010). We assume that knowledge about logistics and the path to success in American science can be instructive and can help to plan and forge beneficial partnerships. This study was conceived as an attempt to document the basic information about the fate of FSU scientists abroad. We were surprised by the paucity of literature on integration of scientists from Russia and other former republics of the Soviet Union in foreign countries. Israel seems to be the only exception and several studies concerning integration of Russian speaking highly qualified workers have been conducted there (Bokek-Cohen and Davidovich, 2011; Kheimets and Epstein, 2001; Remmenick, 2003a: Remmencik 2003, b).

Numerous factors affect integration (Remennick, 2003a). One of them is how immigrants secure employment in the host country. Based on this factor, A. King (2010) divided immigration into three categories: prearranged, educational and spontaneous. According to this classification, prearranged immigration comprises individuals with contract job placement obtained while being in another country. Educational immigration encompasses individuals who happen to obtain their employment after admission for education in the host country. Those individuals who gained their employment by various opportunities after arrival in the new country of residence exemplify spontaneous immigration. While this classification indeed reflects a distinctive modes of mobility which are important for subsequent integration, an argument can be raised whether it is justifiable to call any type of immigration spontaneous and not prearranged. Therefore, we prefer to use the terms employment-based,

education-based and off chance-based mobility or simply emigration instead of those advocated by King. Our study is primarily concerned with employment-based mobility of FSU scientists to North America.

It has been shown that the majority of FSU researchers, about 27%, departed in the 1990's across the Atlantic Ocean to the United States of America (Gokhberg and Nekipelova, 2002). About 2% of FSU scientists ended up taking a job in Canada. Typically, it was a postdoctoral or research associate position. A postdoctoral/research associate appointment is generally thought of as a short-term apprenticeship immediately following the defense of Ph.D. thesis. It is designed to further prepare young specialists (postdocs) for independent research in their transition to tenured faculty position with their own laboratory. A Ph. D. or Philosophy Doctor can be considered as an equivalent of Candidate of Science degree, but is the highest (Doctoral) degree in the United States. It allows its holder to seek a faculty appointment in colleges and universities known collectively as academia. Before the influx of FSU researchers in the 90's, in 1985–1986, less than a half (38 %) of American Ph. D.'s in life sciences had the chance to succeed in making their first step towards tenure, i. e. ascend from postdoctoral to tenure track faculty positions (Trends in the Early Careers of Life Scientists, 1998). In addition, there has been a 42 % increase in Ph. D.'s production between 1987 and 1996 in the USA without a parallel increase in stable employment opportunities. Therefore, FSU scientists faced a stiff competition if they wanted to continue their careers in academic research. In addition, many of them had socio-cultural challenges upon arrival in the New World such as the language barrier, adaptation to a new culture, etc (King. 2010). Taking into consideration all these difficulties, some fundamental questions about integration of FSU scientists in the United States and Canada can be formulated as follows: how many of them succeeded in becoming a part of North American research community? How many of them advanced to become leading scientists? How many of them changed their occupation, migrated to other country or returned home? Gokhberg and Nekipelova (2002) stated that there is no information about professional and social status of those Russian researchers who went abroad for a temporary work and did not return. Only a few contradictory estimates regarding returnees appeared in the press. For instance, V. Kalinushkin, the chairman of the unions represented at the Russian Academy of Sciences commented on the Russian scientists abroad: "Almost none of them have returned" (BBC, 2002). Yet according to Melkova (2001), who referred to the data provided by the Ministry of Science, about 20 % of Russian scholars came back from abroad.

The goal of this project was to explore integration of FSU scientists who arrived in the United States and Canada in the 1990's to conduct biomedical studies. We focused on the professional rather than social aspects of integration and selected a sample of those FSU scientists who gained access into North America via employment-based opportunity (not emigrants). First of all, we aimed to estimate the fraction of FSU scientists who continued their research career in academia, private research centers and hospitals (non-profit institutions) and government agencies. In addition, we traced those who switched to the commercial (for profit) research in companies or firms, and who decided to pursue careers in other occupations such as clinical medicine or teaching. Using available information about funding, we also examined the advance of FSU scientists towards establishing themselves as independent leading investigators. Finally, we estimated the proportion of those individuals who returned home and tried to elucidate factors that affected their decisions.



## Subjects' selection and analysis

***The size and composition of the sample***

We have identified 109 FSU scientists who did not emigrate but entered the USA or Canada earlier than 2000 (mostly between 1991 and 1998) for research. Information about their career path after arrival was collected primarily by personal communications and by the use of Internet. All selected individuals received at least one degree in biomedical sciences (mostly candidate as equivalent of Ph.D. and a few M. D.) before arrival to the host country. A little less than one third of them (30 individuals) came to the sight of the first author prior to his departure to the United States. The majority (26 out of 30 individuals) was from Sechenov Institute of Evolutionary Physiology and Biochemistry of Academy of Sciences in St Petersburg, where the first author worked until the end of 1991. The rest of the scientists were met by the first author either at international conferences in the 90's (39 individuals) or during his one and a half year stay in Miami and six and a half year residency in Memphis (38 individuals) after his arrival in December of 1991. In addition, information about 2 scientists was acquired as a result of correspondence via electronic mail in the process of sharing mutual research interests. The first author of this paper is also included into analysis, which makes the total number of individuals in the sample 110. Most of them specialized in physiology, biochemistry and cell biology of the nervous/visual and circulatory systems, a smaller part — in microbiology, immunology, virology, organic chemistry, and clinical sciences. Geographical origin: Moscow or its region — 46, St. Petersburg — 39, Kiev — 6, Novosibirsk — 5, Minsk — 3, Donetsk — 2, Kazan — 2, Kishinev — 2, Odessa — 2, Erevan — 1, Irkutsk — 1, Tbilisi — 1. They found employment at various research centers across the USA (104) and Canada (6). Gender distribution: 67 males, 43 females.

***Verification of occupation of the subjects***

To verify that a FSU scientist still belonged to the North American academic or government research community, we collected evidence using personal communications, information obtained from websites of universities, government institutions, at conferences, or from publications dated as of 2007or more recent for each subject. Publications served as the primary way to identify those individuals who were able to secure funding and progressed towards independent research in academia. We also identified individuals who returned home, or left academia for medical practice, for research or other activities in biomedical companies, or moved to countries other than United States and Canada.

## Results

*1. What % of FSU scientists who arrived in the period 1990–1999 continued as a researcher in academia, non-profit and government institutions in North America as of 2007?* **(75 out of 110) ~ 68.2 %**

Out of 110 FSU scientists 31 (28 %) were able to secure funding for promotion to tenure positions in universities and 4 became group leaders in non-profit and governmental research institutions. Among them 24 were males and 11 were females.

*2. How many % of FSU scientists went back to their homeland?* **(8 out of 110) ~ 7.2 %**

*3. What % of FSU scientists left academic research for full timework in biomedical companies?* **(10 out of 110) ~ 9.1 %**

One individual switched to sales, not to research.

*4. What % of FSU scientists came to North America and left to conduct research in Europe or Australia?* **(7 out of 110) ~ 6.4 %**

3 left to Italy, 2 — to Germany, 1 — to Australia and 1 — to Spain.

*5. How many % of FSU researchers left academic research for medicine?* **(7 out of 110) ~ 6.4 %**

* one individual passed medical exams and was allowed to practice as a clinician, but remained mainly in academic research

*6. What % of FSU scientists left academic research for teaching?* **(3 out of 110) — 2.7 %**

The results are summarized in Figure 1.

## Discussion

The value of our study depends on the answer to the question whether our data accurately reflect the process of integration in the whole population of FSU biomedical scientists who came to the United States and Canada in 1990's. Several authors who studied international mobility of highly skilled professionals already discussed obstacles for data acquisition and analysis (Canibano et al., 2011; Fontes, 2007; Jimenez at al., 2010; Laudel, 2003). Fontes (2007) stated that majority of empirical studies use "convenience samples" (i. e. researchers from specific organizations, scientists who were part of national or international programs, etc) due to methodological difficulties in delimitation of "population" and in measuring flows of subjects. Our study is not an exception from this general pattern. All subjects in our study fulfill the required selection criteria (i. e. arrival to conduct research with non-emigrant status in 1990–1999 and a doctoral degree) whether they were acquaintances of the first author from St Petersburg, from Memphis/Miami or attendees of international conferences met by chance. We think that high proportion of scientists from St Petersburg in our sample did not invalidate our results. Whether they came from Moscow, St Petersburg, or Kiev or any other city, they all showed potential to do quality work to be recruited for research associate/postdoctoral positions abroad. Besides, almost all of them had ties to leading academic institution in Moscow or St. Petersburg anyway. It is true, however, that some of them were better prepared and efficiently used advantages from previously established connections with renowned scientists and/or from support of those collaborators and friends who already made their way across Atlantic Ocean. Others were accepted by less prominent researchers and had little support from the network of colleagues. Nevertheless, all of them should have been able to present themselves for potential hosts through publications in English and/or via personal communications. The subjects in our study can be viewed as "convenience sample" that represent a broad spectrum of specialties and major biomedical research institutions of the former Soviet Union. Overall, we think that our approach permits certain insights to be gained about the process of integration of FSU scientists in North America.

Another question of concern for us was whether we could have expanded our sample. We are aware of publications of numerous FSU scientists in biomedical field whom we did not include in our sample. As a rule, these authors showed high productivity. Indeed, publications actually can help in identifying elite scientists (Laudel, 2003). However, they cannot be useful to trace trajectory of those scientists who did not succeed in academia or opted for other occupations in a short time after their arrival in the USA. We, however, wanted



to achieve a rather balanced reflection of all FSU researchers who came to North America. Obviously, some of them were not productive in terms of papers. Therefore, to avoid overrepresentation of highly productive, successful researchers in our sample we did not include those FSU scientists who could be identified by publications. In addition, through references of our colleagues we are aware of several FSU scientists who left US academia and returned home, or took teaching position, or went to work for a company. Their exclusion is justified by difficulties in verifying their career path and adherence to the selection criteria.

Are our results consistent with those reported by previous investigators? Although we were unable to find similar studies, the validity of our approach is supported indirectly by our additional observations, which are in accord with those reported previously. For example, it has been concluded that the scale of temporary engagement of Russian research scholars abroad significantly exceeded emigration of researchers (Gokhberg and Nekipelova, 2002: Ушкалов и Малаха, 2000). One then can predict that employment-based immigrants from FSU should greatly outnumber emigrants in the research community of the United States. Indeed, we did not find any Russian-speaking emigrant at a research associate position at the University of Tennessee Medical School in Memphis. By contrast, more than 20 of these positions were occupied by Russian speaking scholars admitted to the United States on temporal visa. The overwhelming predominance of Russian speaking occupants of postdoctoral positions in North America with temporary status in the 1990's is further supported by the frequency of random encounters at international meetings experienced by the first author. Only 3 emigrant attendees had been met by chance while the total number of conference encounters with non-emigrant postdocs during the same period of time was more than ten times greater. Some emigrants discussed with us their difficulties in obtaining employment in research. It has been estimated that the share of professionals who could regain their original occupations among post soviet emigrants is about 30 % in Israel and in the United States (Remmenick, 2003b). The observed pattern, therefore, confirms the statement of King (2010) that employment-based mobility provides advantages over emigration in the process of integration of scientists in a foreign country.

Our data suggest a high rate of retention of FSU scientists in academia, traditionally a major sector for employment of postdoctoral researchers. More than two thirds of them were still employed there in the second half of the first decade of the new millennium. A sector of employment where we expected to find a higher number of FSU scientists was commercial research or for-profit industry. Just above 9 % of FSU scientists who started as postdocs were found to be employed in the biomedical companies. By contrast, according to Regets (1998), about 13 % of postdocs engaged in biological research for two years in the USA left their positions for industry in 1995. The corresponding number for postdoctoral researchers in chemistry is even higher — 32 %. Further, an increase in these percentages with time logically can be expected since the majority of postdocs would not acquire faculty positions. How can the low percentage of industry employed FSU scientists in our study be interpreted? One possibility can be a lower chance for detection of industry oriented FSU scientists by our approach. Major hubs for biomedical companies are California and New England States, especially New York and Massachusetts. Perhaps, we would have a higher chance to encounter researchers employed in industry if we lived in those locations. In addition, people oriented for commercial research may not have been very active academically, i. e. may not have been inclined to present often at conferences. In fact, only once at meetings we met a half of postdocs who later went to industry. Also, we encountered 2 Russian Ph. D. holders from New York who got jobs in the local companies without postdoctoral

experience in the USA. One of them, however, switched to academia and was included in our study. These considerations support the probability that the percentage of FSU researchers who entered commercial research can be higher than 9 %. Higher salary seems to be the major factor that attracted FSU specialists to this sector. Employment at commercial firms, however, has its disadvantages. For instance, a Russian scientist complained that her work for a biotechnology firm in Texas provided no room for her creativity and intellectual freedom (Ninetto, 2000). She returned to Russia (but left research anyway). In addition, it may be generally perceived that this occupation has a high risk of unemployment. Despite our inability to keep constant track of all FSU researchers employed in industry, we have detected temporal job loss by 2 of them. These considerations about job stability and stifling of creativity may have deterred some of FSU researchers from the commercial research.

Another occupation where a higher salary undoubtedly attracted FSU specialists is clinical medicine. However, only relatively young individuals with medical degree pursued this path because it requires passing national licensing examinations in several stages, which usually takes several years. In addition, continuation of this career would require successful entrance and completion of medical residency, which adds at least three more years to the process of education. We have observed that research is a common "springboard" for a highly lucrative medical career in the USA which attracts a broad pool of international scholars, especially from India and China. All these researchers including those from the FSU contribute to a buildup of the high level of competition for medical residence positions. On the other hand, prospects of employment in the medical sector of economy, in contrast to research, seem to be more certain, stable and profitable. There is a community of Russian speaking physicians in the USA and Diaspora networking organizations such as Russian American Medical Association has been formed. Overall, medical doctors were obviously a minority in the population of FSU immigrants-researchers and the modest (6 %) outflow of them to the clinical practice reflects this fact.

A small fraction of FSU scholars (6 %) left the USA or Canada to continue their research in Europe or Australia. It might be expected that they had connections in the country of their destination. For example, a couple of FSU scientists moved back to Italy. In the past, one of them received Ph. D. and both of them enjoyed their research in this country prior to their American postdoctoral experience. In the case of departure to Spain, family factors and cultural experience did play a significant role as well. Professional prospects seemed to underlie the decisions by the scholars who moved to Australia and Germany. Once at a conference, we also met an individual who left the USA for a good position in England. He was not included in our study since we were unfortunately unable to track his career. It is clear that both conditions related to the personal life and professional considerations have an impact on the decision of scientists to seek their fortune in another country. Several researchers in our sample had an opportunity to visit and work in European countries prior to their departure to the United States. Not many of them, however, did go back to Europe. Overall, the small percentage of people in this group obviously indicates that departure from North America was not a typical path. The same conclusion can be applied to the group of those researchers who took teaching as their primary task. In general, research, not teaching, is a crucial factor for promotion in an American university. Therefore, among the faculty teaching is frequently perceived as a detractor from more important activity and a burden. Nevertheless, two out of three individuals in this group became faculty in the American medical schools. The number of these appointments is very limited and one has to demonstrate impressive skills as a lecturer to be selected for this position. It appears that



an active involvement in education of students was an important ingredient for professional fulfillment of the scholars who chose this career.

Our results suggest that return mobility of those FSU researchers who arrived in 1990's in North America was lower than 10 %. Melkova (2001), who referred to the data provided by the Ministry of Science, stated that about 20 % of Russian scholars came back from abroad. There is no contradiction between these two estimates since our assessment is concerned only with the cohort of scientist who arrived in the United States and Canada. As we mentioned previously, quite a few FSU researchers went to Europe and returned home prior to their departure to the New World. We already alluded to the methodological difficulties in studying mobility of scientists. Shuttle or pendulum migration, which probably was (Ninetto, 2000) and is (Kugel, 2010) the dominating pattern of mobility of scientists in Russia, certainly complicates the assessment of outflow. In fact, some FSU scientists in our sample returned home for a brief period of time, but later again left to the USA. They explained this move by inability to perform research in the post-soviet countries. Among the 8 scientists from our sample who returned permanently to Russia, 3 left research and went into business. Five other still retain their employment in the Academy of Sciences, but their low productivity underscores difficulties in conducting investigation in Russia and suggests partial involvement in other activities unrelated to research. Factors that appear to prompt the decision to return in some cases were family matters: divorce in a short period of time after arrival to the North America, unwillingness or inability of fiancé or a significant one to leave home. In other cases, disenchantment with sciences and new opportunities in business in Russia has been communicated as the reasons to us. Casey and co-workers (2001) and Fontes (2007) provided the detailed analysis of factors that affect the decision of scientists to return which is out of the scope of our study.

## Conclusion

The breakdown of the Soviet Union resulted in the cardinal changes in the societies of newly formed countries and altered perspectives for scientists. A massive wave of highly skilled professionals left the Commonwealth of Independent States in the 1990's. The United States became a major destination for researchers with temporary contracts. Our data show that the transition of scientists from the post Soviet countries in North America was successful and the bulk of them continued research in academic, non-profit and government institutions. Our results also demonstrate that migration across Atlantic Ocean was not a "river of no return" or "one way highway". We believe that the analysis of integration of scientists, the process that can be considered as one of the most important determinants in international mobility of highly qualified human resources, deserves a close attention of sociologists and requires further studies.

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# Internationalization: Cultural Adjustment of Foreign Students in the Estonian Higher Educational Context

There are a growing number of research articles pointing out the challenges university systems face that are connected with the increasing internationalization of education. Estonia, for example, is pressed for several reasons (including its demographics) to plan an effective response to the need for the internationalization of its university programs. Accompanying the need for research on managing the challenges of the internationalization of university level education is also the need for research on the particular problems students have in adjusting to the internationalization of higher education in the Estonian context. The Estonian higher educational systems, are increasingly realizing that there is a need of adjusting to internationalization. This means altering the traditional institutional identity to fit
the demands of a globalized world. This article explores the challenges connected with the internationalization of higher education in Estonia however the primary concern is for facilitating internationalization in a way that enhances the learning experience for students in international programs. This article is based on a quantitative measurement of the role of culture shock in the learning performance of students studying at Tallinn University of technology. In that respect the article examines the adjustments and adaptation necessary for students studying in the Estonian cultural context.
***Keywords:*** Cultural Adjustment, Cultural Shock (GHS), Self-Identification, Cultural Fatigability

## Introduction: Understanding and Facilitating Cultural Shock

The concept university implies that the scope of the university community is itself international. This is based on the premise that reliable knowledge cannot be produced in local isolation but can only be obtained by an open and honest inquiry that is international

in its scope. That is, the nature of today's global reality necessitates structuring the higher learning experience so that it prepares the student to deal with the globalized world and with global interdependence. The main aspect of these modern developments as far as domestic centers of higher education are concerned is the internationalization of educational services and educational institutions. The internationalization of higher educational systems is driven by national, regional and global forces. This has pressured universities into engaging and attracting international scholars, plus engaging and attracting international students. It is only by keeping up with the demands of internationalization (by engaging in reliable knowledge exchange with international partners) that a university can raise its reputation to international standards.

There are a growing number of research articles pointing out the challenges university systems face that are connected with the increasing internationalization of education[1]. According to the Estonian Higher Education Strategy (2006–2015) the Estonian Ministry of Education, for example, acknowledges that for several reasons (including its demographics) it is necessary to plan an effective response to the demand for the internationalization of its university programs.[2] Accompanying the need for research on managing the challenges of the internationalization of university level education in Estonia is also the need for research on the particular problems students have in adjusting to the internationalization of higher education in the Estonian cultural context.

This article explores the challenges connected with the internationalization of higher education in Estonia however the primary concern is for facilitating internationalization in a way that enhances the learning experience for students in international programs. This article is based on a quantitative measurement of the existence of culture shock in the learning performance of students studying at Tallinn University of Technology. In that respect the article examines the adjustments and adaptations necessary because of the experience of culture shock that students experience in an unfamiliar cultural environment.

Loone Ots pointed out, that there is a growing interest amongst foreign students for studying in Estonia. Ots thought this could be due to "An attraction to what appears to be an exotic place, a general desire to become acquainted with former socialist countries and an interest in visiting as many other different universities/countries as possible."[3] However his article also highlighted the fact that almost all foreign students were reporting having cultural shock as a part of the adjustment to studying in Estonia.[4] Thus, because the Estonian higher educational system is increasingly finding itself in need of adjusting to internationalization it must alter its traditional institutional identity to fit the demands of a globalized world.

The internationalization of higher education has increased the challenge students face in adjusting to unknown cultures. These challenges have been studied by specialists analyzing different aspects of the educational process and the impact that internationalization has on the educational process. Their careful analysis reveals that one of the difficulties that students face in adjusting to studying abroad is culture shock (when an unknown culture has a stressful influence on a person, sometimes described as cultural fatigability or just stress). An Australian research project analyzing the experience of international studying at an Australian university defined the students adjustment challenge as "The sudden loss of all familiar signs and symbols of everyday life, with consequent psychological stress and use of coping strategies to deal with the stresses encountered."[5] The notion of "culture shock'' was introduced by Kalervo Oberg in 1960 when he noticed that entrance into a new culture can be accompanied with a number of unpleasant feelings. Nowadays it is considered that the experience of culture shock is stressful because it is unexpected, on the one hand, and can lead to a negative evaluation of the new culture, on the other hand. The stressful impact of a new culture on a person is called culture shock, or stress, or marginal stress, or cultural stress fatigue by contemporary scholars. Everyone who enters an unfamiliar culture experiences it.

To some extent most people who have changed their place of living to a new culture suffer from some degree of culture shock. Culture shock has psychological and physical consequences that play a role in the adjustment to new situations. Today, with a vast increase in the number of foreign students in our domestic centers of higher education, if institutions of higher learning fail to take cultural competence into consideration, students can be left with various unpleasant emotions connected with adjusting to an unfamiliar culture-ranging from culture shock, on the one hand and on the other hand such unexpected experiences can lead to a negative appraisal of the culture and the educational experience.

The first segment of the article describes culture shock and introduces why it is a factor in the adjustment process of foreign students. The second segment of the article quantitatively measures the impact of culture shock on the experience of foreign students studying in an English speaking International Program at Tallinn University of Technology. The third section of the article explains the method used for and the process of analyzing the research results. The fourth section of the article explains the conclusions drawn on the basis of the research.

## 1. Culture Shock as an Adjustment Factor for Foreign Students

Helen Spencer-Oatey and Peter Franklin (2009) explained that culture shock can occur in one or all of the following ways:

— pressure because of the efforts applied to an attempt at psychological adaptation;
— sense of loss in relation to friends, status, profession and possessions;
— feeling of isolation in new culture which can turn to the negation of the unknown culture;
— confusion of role expectations and the feeling of self-identification;
— anxiety passing into indignation after the comprehension of cultural differences;
— feeling of inadequacy because of the inability to cope with the situation.

The main reason for culture shock is that experiences and interactions in the new cultural setting do not conform to an individual's psychological expectations. Every culture has its own unique set of symbols and images, expected patterns of behavior and interactions

[1] *Johnson L. & Tucker Ch.* (2008) Cultural Issues // Handbook of Clinical Psychology, Children and Adolescents / ed. by M. Hersen & A. Gross. Hoboken, New Jersey, Wiley and Sons Inc. 790 p.

[2] Estonian Higher Education Strategy 2006–2015 / Estonian Ministry of Education and Research. November 2006.

[3] *Ots L.* (1988). Some Notes on Teaching in a Multicultural Environment: the Estonian Literature Project at the University of Tartu // Higher Education in Europe. Vol. 23. № 3. P. 376.

[4] Ibid. P. 376.

[5] *Thomson G., Rosenthal D. & Russell J.* Cultural Stress among International Students at an Australian University. Australian International Education Conference 2006, 3.

that are common to various situations within the culture. The environment of a new culture makes the individual's habitual system of orientation inadequate because it is based on a different representation of the world, different norms and values, plus different perceptions of behavior, and different behavioral expectations. Interacting in a culture that one is habituated in means that the person can behave without thinking about the existence of a majority of factors that lie beneath appearances ("cultural iceberg theory'' Trompenaars 1998). In other words, as Trompenaars points out, there is a whole realm of significant information about a culture that is not apparent, resulting in a hidden system controlling behavioral norms and values. Thus when a person has contacted with an unknown culture he or she can feel psychologically and sometimes physically uncomfortable. This feeling of discomfort is the result of culture shock.

**1.1.** The level of intensity, duration and need for adaptation to cross-cultural shock depend on many factors. All of these factors can be divided into two groups: internal (personal) and external (group). In the first group of factors the most important factors that need to be taken into consideration are the individual characteristics of a person-such as gender, age and personal traits.

**Gender** influences the process of adaptation and duration of culture shock (hereafter CSH). Research on what is involved in adapting to new cultural settings states that the process of adjustment to a new environment is more complicated for women than for men. However this is most common when women come from traditional cultures where their life is limited to activity around the home. As for women from developed countries these differences are blurred and research indicates that women can be as successful as men in adapting to new cultural settings.

**The age** of a person is considered to be a significant adjustment factor in the process of adapting to an unknown community. The older the person is the more difficult the adjustment to a new cultural system, it is harder and takes longer to overcome CSH and older people more slowly overcome the difficult challenges that patterns of an unknown culture pose for them.

**Educational factors** are more and more becoming a considerable adjustment factor. The more educated the person is the more successful his or her adaptation. Education, even without taking into account its cultural content, expands the internal resilience potential of a person. The more complex the inner world of a person is the faster and easier the time needed for creative innovation.

**1.2.** Among the external factors influencing adjustment and CSH cultural distance can be designated as a main one. The person`s perception of cultural distance depends on many factors: economic factors, emotional factors and the person's language skills. If the values of one's culture differ from those of another culture and cultural difference is huge adjustment can be long and painful.

**Previous experience of living in an unknown cultural environment is conducive to better adjustment.**

**The peculiarities of one`s culture** can be crucial to adjustment. Representatives of nationalities who are afraid to "lose face" or for those of ``the more powerful nations (G8 countries) the adjustment is mostly stressful.

**The social and cultural conditions of the visiting country,** such as the friendliness of locals to foreign students, their willingness to help foreign visitors and socialize with them, are very essential for aiding a healthy adjustment.



**The circumstances of one's life experience** (related to the internal factors of adjustment and the motivation to adjustment) are the most influential factors. This aspect of motivation is very high among students who are studying abroad. In order to reach their goals they try to adjust as quickly as possible.

CSH is a complex process for students but the results which can be reached (such as new perceptions of the world based on understanding and accepting cultural diversity) are worth the effort it takes to overcome it. The key advantage of effectively managing CSH is the priceless experience and acquired skills students can draw from while living and working in our rapidly changing world with reduced borders where competence in intercultural relations is becoming more important.

## 2. Measuring the Impact of Cultural Shock on the Experience of Foreign Students

The hypothesis is that students are experiencing culture shock when studying in this educational context. For that reason the research aims to analyze the adjustment of foreign students getting higher education in Estonia and the peculiarities of CSH manifestation in this context. In addition the research will analyze the existing connection between the factors of adjustment (both internal and external) and the components of CSH. The research-conducted at Tallinn University of Technology between 2010 and 2011-indicates the peculiar incidents of culture shock occurring among the foreign students who have come to study to Estonia.

The initial focus of the research was the academic assessment of the first year students (first and second terms), internal factors of adaptation-gender, age and the level of the ethnic "Self" of the students of the experimental group, plus the particular peculiarities and psychological conditions related to cultural shock occurring with foreign students studying at higher education centers in the Estonian culture.

The subject of the research was a group of the foreign students, studying in the English program at The Economic Department at Tallinn University of Technology. The sample size was 61, between the ages of 18-45.

### 2.1. Preliminary Pilot research

On the basis of comparing the academic assessment results of the first (fall) and second (spring) terms it can be vividly seen that students from the Economic Department of the International Program of TUT definitely had adjustment difficulties. This observation prompted the research team to construct the hypothesis that the first year students were initially suffering from cultural shock (CSH) that resulted in a decline in academic performance.

As a means of testing the hypotheses, a pilot investigation was conducted. The goal of the pilot study was to clarify whether or not it is possible to improve the academic performance of students at higher educational institutions of Estonia by being more aware of and better facilitating their adjustment challenges.

For examining the hypotheses a sample group-of 41 students out of the total number of foreign students who came to study in the Economic Department of Tallinn University of Technology at the state capital, Tallinn, in international programs in the English language

were examined. These students have come to Estonia from the many different countries of Europe and Asia (Appendix 5). This is their first year of study and living in Estonia and English is not their mother-tongue.

The assessment of the student performance (from the Economic Department) during their first academic year was analyzed to provide an objective indicator of the academic progress for the fall and spring term. The results are presented in Table 1. It should be noted that individual students could have taken several different classes during the term so the total number of grades refers to total results of the 41 students.

Table 1

The changes of academic assessments of foreign students of Tallinn University of Technology (Economic Department) during the first academic year[6]

| | Fall term | | Spring term | |
|---|---|---|---|---|
| Assessments | Number of students | % | Number of students | % |
| 5 | 26 | 10.20 | 48 | 17.78 |
| 4 | 68 | 26.67 | 80 | 29.63 |
| 3 | 51 | 20.00 | 72 | 26.67 |
| 2 | 39 | 15.29 | 43 | 15.93 |
| 1 | 29 | 11.37 | 13 | 4.81 |
| 0 | 42 | 16.47 | 14 | 5.19 |
| Σ | 255 | 100 | 270 | 100 |
| $\chi^2$ | | | | 38.72** |

**2.2. Arranging and carrying out the second stage of testing**

**Aim of research:** research and single out the main components of the culture shock of the first year foreign students in the Estonian cultural environment.

**Subject of research**: peculiarities of culture shock in this context, the ethnic identity of foreign students of the Economic Department, and the connection between both internal and external factors of adjustment and components of CSH.

**2.3. Hypothesis of research:**

**Hypothesis 1.** It is supposed that during the first year of study in an unfamiliar culture students have acute ethnic self-identity awareness and feel cultural differences when communicating with representatives of other cultural and ethnic groups.

**Hypothesis 2.** It is supposed that during the first year of study in the Estonian culture (because students study in a language other than their mother tongue and in an unfamiliar cultural environment) CSH has specific features that are experienced by the students.

**Hypothesis 3.** It is supposed that there is a correlation between the factors of cultural adjustment and CSH.

[6] As it can be seen from table 1 the percentage of high grades has increased in the spring term compared with the fall. The analysis by means of criterion $\chi 2$ shows that the level of distinctions in the percentage distribution of estimations is statistically significant ($p < 0.01$). Thus, the academic progress of foreign students has definitely increased during their first year of living and studying in Estonia.



**2.4. The objectives of the research:**

1. Determine the ethnic identity of the students from different countries that are studying in Estonia.

2. Determine the peculiar features and components of the CSH for students studying in Estonia.

3. Determine whether or not there is a considerable connection between the ethnic identity of the students and components of CSH.

4. Determine the extent to which there is a connection between internal and external factors of adjustment and CSH that must be taken into consideration.

**2.5. Methods and methodology of research**

The basic method of research for this study is experiment. The basic method used for collecting empirical data is testing. The method used for statistical data handling is correlation analysis according to Spearman's rank correlation coefficient and qualitative analysis is carried out by content analysis.

**2.6. Methodology of research:**

1. Test for ethnic self-identity " The Who am I Test" (M. Cuhn and T. McPartland, modified by Z.V. Sinkevich in 1954)[7].

2. Test for research culture shock "Culture Shock Test" (Bardier G. L.).

**2.7. Description of the methodology of the research:**

1. "Who am I" test

The administering of the test to determine personal identity was developed by American sociologists and socio-psychologists M. Cuhn and T. McPartland

(1954)[8]. They included this self- attitude test into a sociological questionnaire.

There have been some modifications to "The Who am I" test. One such modification was reflected in the research of Z. V. Sinkevich where both the original version of "The Who am I" test and some variations were used.

For scrutinizing the level to which students felt or expressed their ethnic "I" Sinkevich asked a question and offered multiple choice answers.

For identifying stereotypes that can contribute to negative cross-cultural experiences the test offered the following multiple choice question: "Do you notice the nationality of people around you?"

The questionnaire contains multiple questions on Individual-personal ethnic self-identification, specifying the nature of the person's emotional-sensitivity (people often do not think about belonging to a particular ethnic group, it sometimes doesn't occur to a person whether or not they have such a feeling).

2. "Culture shock" test

The culture shock (CSH) methodology was developed by G. L. Bardier. Empirical research on culture shock was initially developed by Bardier as a method of qualitative research, where the respondents' answers were processed with content-analysis techniques. During a pilot research a method similar to "The Who am I" test by M Cuhn and T. McPartland was experimented with for the purpose of further developing " The Who am I" test. In the beginning the given instructions allowed the students to freely express themselves.

[7] The Sinkevich version of the Who am I Test taken from: *Pochebyt L.* (2005). Vzaimoponimanie kultur // Metodologia i metody etnicheskoi i kross-kulturnoi psihologii. St Petersburg: St Petersburg University.

[8] Ibid.

The respondents were asked to describe situations in which they experienced or faced cultural shock. But later the instructions become more precise where a definite understanding of culture shock was called for. The final version of research methodic was developed on the base of the perception of culture shock as a reflection of cultural differences (Appendix 4).

**2.8. The Handling of the Mathematical Data**

The following criteria are proposed for selecting the categories of content analysis results of the CSH measurements.

The first criterion-components of the settings and most common ethnic traits dominant in a particular situation:

- "Cognitive", connected mostly with presentation, beliefs and understanding;
- "Affective", connected mostly with feelings, emotions and understanding;
- "Connotative", connected mostly with behavioral activity.

The second criterion- the intensity of personal involvement in a situation:

- Consciousness of the personal involvement in the situation;
- Unconsciousness of a situation, when previous personal experience is used as a reference;
- Unconsciousness of a situation, on the basis of national traditions and collective
- experience.

The third criteria — sources for the appearance of intolerance in a situation:

- Active intolerance, when a subject of communication himself is the source of intolerance;
- Reactive intolerance, when the object is another person, a communication partner;
- Situational intolerance, sources which are occasional circumstances, which spontaneously and vividly reveal cross-cultural differences.

The fourth criterion — the further development of the situational criteria:

- Obstacle-fixation of contradictions in cross-cultural communication and a number of negative ethnic stereotypes, which decelerate the further development of the interactions;
- Vector-the changing of the content results in the changing of situation as a whole, the contradictions can either resolved or on the contrary can be exaggerated;
- Fan- appearance of multi-dimensional situations, which include both ethnic stereotypes, the circumstances of their appearance and personnel traits of the interacting partners.

The firth criterion — positional symmetry-asymmetry of the installation of an object:

- Open intolerance — pressure, aggression, hostility;
- Hidden intolerance — adjustment, forced submission, abandonment of personnel national identity;
- Tolerance-acceptance of the other's identity without damaging one's own personal identity.

The sixth criterion-interaction history of the cultures:

- Assimilation experience (affiliation resulting from one culture assimilation another);
- Irradiation experience (discrimination, colonization);
- Integration experience (overcoming segregation and confrontation).

The seventh criterion-situation related to definite field of cultural expression:

- Intolerance in the worldview sphere (values, world outlook, ethics, aesthetics);
- Conventional intolerance (personal space, interpersonal distancing, ways emotions are expressed, common patterns of building relations, ways of thinking, problem solving, public behavior);
- Everyday intolerance (food, clothes, manners, basic life demonstration).



## 3. The Analysis of Tests Results

**3.1. The analysis of "Who am I?" test**

The classical (original) version of "The Who am I?" test was used in this research. The extent or intensity of the ethnic "I" intensity was identified by the questions mentioned below. The results of the research demonstrated that for 80 % of the tested students their ethnic background is important, 16 % revealed an average accentuation of the status of ethnicity, 4 % did not show the status ethnicity but at the same time they feel a belonging to either the citizenship of the world or as European, 42 % of the tested demonstrate their national identification and simultaneously their belonging to Europeans.

Table 2

The extent of intensity of ethnic «I» n=61

| | Not at all | To a certain degree | Most likely | (N/A) |
|---|---|---|---|---|
| Citizen of the world | 3 % | 62 % | 30 % | 5 % |
| European | 5 % | 30 % | 42 % | 23 % |
| Identification with your nationality | 4 % | 16 % | 80 % | — |

For identifying negative cross- cultural stereotypes the following multiple choice questions were offered.

Table 3

Fixation on the nationality of people

| Possible answers | Percentage of responses |
|---|---|
| Usually, I do not | 31 % |
| I do, if I dislike like them | 16 % |
| I do regardless of my likes or dislikes | 53 % |

On the basis of the results received it can be seen that almost 53 % of respondents consciously or unconsciously fix their attention on the anthropological traits of ethnicity, 31 % do not do it at all and 16 % do it in cases where there is something unattractive in the appearance or behavior of those around them. This question reveals the existence of unconscious ethnic prejudices.

In addition, in the questionnaire there are multiple questions on an individual personal-ethnic identity.

Table 4

Specifying emotionally-sensitive nature of individually-personal ethnic self-identification

| Possible answers | Percentage of responses |
|---|---|
| Yes, I do — ... to a certain nationality | 58 % |
| I feel that I belong to several nationalities | 35 % |
| No, I do not associate with any nationality | 7 % |

The types of answers given indicate the emotionally sensitive nature of ethnicity: people do not place the emphasis on their national identity (they either have strong feelings of identity or a very weak sense of national identity). According to the results of the respondents almost all of them feel a belonging to some nationality: **58 %** associate themselves with a certain nationality (feel it) and **35 %** feel a belonging to several nationalities. **7 %** do not identify themselves in terms of nationality.

**3.2. The analysis of Cultural shock test**

For culture shock research 61 students were questioned and questionnaires from 26 were returned. (Appendix 4) The students were asked to describe situations when they felt culture shock when meeting an unknown culture.

Study of peculiarities of CSH manifestation.
Criteria of CSH manifestation n = 26

Table 5

| Affectifve | Cognitive | Conotative | Conscious | Unconscious | Traditions | Object | Case | Obstacle | Vector | Fan | Open | Hidden | Tolerance | Assimilation | Integration | Conventional | Every day life spheres |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34% | 10% | 20% | 11% | 13% | 42% | 9% | 65% | 32% | 31% | 7% | 5% | 15% | 61% | 9% | 17% | 10% | 20% |

The largest number of responses was determined by the "Attitude Criterion" — on the affective component of Attitude Criteria — 50 % of all responses. By "Level of Personal Involvement Criterion" of CSH, 42 % of the respondents interpret the situations when they feel discomfort as a manifestation of traditionalism — as manifestation of traditions operating at an unconscious level.

In terms of "Source Criterion" the majority of those tested (65 % of responses) indicated casual manifestations-for example: natural circumstances and the differences in the understanding of a situation-were connected with how they experienced the situation. The situation is fixed as an obstacle by the "Forecast of the Shock Development Criterion" — 35 % responses — but there is a trend that in other circumstances the anxiety producing situations cannot happen ("Vector Component") — in the case of changing the context of a situation there is no feeling that this situation can happen again — 30 %.

Under the "Disposition Criterion" the personal disposition was revealed — 60 % tolerance reactions. As for intolerance (by the "Intolerance Component" — 13 % responses) — its manifestation mostly relates to every the day sphere without touching the deeper levels — the levels of persuasion, values and attitudes. By the CSH "Experience Criterion" — 20 responses, it demonstrates a forecasting development of CSH, so the revealed "Integration Component" shows more positive cultural experience, consequently as a strategy for acculturation is one of the most successful possible-the preservation of one's cultural identity along with acceptance of the other culture (integration).

According to the results of the correlation analysis of the Cultural shock (CSH) test certain regularities have been revealed. When in an unfamiliar culture students described the



situation when they faced unfamiliar examples of behavior, which made them, feel uncomfortable. As a result of researching and analyzing the situations described as uncomfortable by the students the following data have been revealed, the following conclusions have been made, and the correlation analysis has been done.

**3.3. The results of Correlation analysis**

After the correlation analysis the ethnic identity correlation was researched and the following correlations have been revealed. For $n > 40$, assuming independence, $\rho$ is approximately an observation from a normal distribution with mean 0 and variance $1/(n - 1)$. The critical values of the one-tailed tests using ρ. The entries in the table are the smallest values of $\rho$ (to three decimal places) that correspond to one-tail probabilities $\leqslant 5\%$ (or 1 %). The observed value is significant *if it is equal to*, *or greater than*, the value in the table[9]. The exact significance level never exceeds the nominal value (5 % or 1 %). At a level of significance r -0.05 at pcrit = 0.252[10] level of significance the following correlation has been found:

*Age*-Response to *My identification with an ethnic group, cultural group or with a national group* has the coefficient correlation of p = -0.307 (p > pcrit) which means that the older students are the less they identify with any ethnic group (Appendix 1, Table 1).

The following additional correlations have also been found:

*The impact of an European Identity — How strong is the identity with your nationality* has a inverse correlation with coefficient of correlation p = -0.29 it means that identification with a European status weakens one's sense of national identity.

*Number of countries visited before — My identification of other people* at coefficient of correlation p = 0.29 means the more countries one has visited the more one pays attention to anthropological behavioral features of people: because the person feels more ethnic prejudices.

During the research of correlations between components of cultural adjustment and component s of CSH considerable correlations have not been revealed (except the items mentioned below):

*Tradition-Age p = -0.452*
*Tolerance-Gestures significant p = 0.342*
*Hidden intolerance — Citizen of the world p = 0.444*
*Open intolerance — Language p = 0.716*
*Case — Identification with your nationality p = 0.439*

During research the correlations between components of CSH the following correlations can be figured out:

At a level of significance p = 0.001 at pcrit = 0.607[11] (Appendix 2, Table 2)
*Tolerance — Case* p = 0.725 (p > pcrit)
*Tolerance — Traditions* p = 0.646;
At a level of significance p = 0.05 at pcrit = 0.496[12] (Appendix 2, Table 2)
*Tolerance — Obstacles* p = 534; (p > pcrit)
*Tolerance — Fan* p = -0.458; ...

[9] *Nasledov A. D.* (2004) Matematicheskije metodi psihologicheskihh issledovanij. Analiz i interpretacija dannihh. St Petersburg: Rech. P. 363–364.
[10] Ibid.
[11] Ibid.
[12] Ibid.

*Tolerance — Affective comp*. p = 0.5.

Thus we can draw the conclusion that the Tolerance Disposition in connection with another culture inversely fixes the differences in cultures, by describing other people's peculiar behavior as due to how one reacts to perceiving different cultural traditions and if to think about it from a point of predictability it does not influence the multiplication of uncomfortable situations (in reverse correlation *Tolerance — Fan)* it does not deepen contention and they are passively accepted as typical to the culture's traditions.

The additional correlations also have been found (Appendix 3, Table 3)

## 4. Conclusions Drawn on the Basis of the Research

### 4.1. Conclusion one

The results of ethnic status (Table 2) demonstrated that ethnic status is important for about **80 %** of respondents, **16 %** showed an average accentuation of ethnic status. **42 %** of respondents in addition to their national identification feel their identity as Europeans.

According to the results of ethnic self-identity (Table 3) mostly all respondents demonstrate the feeling of belonging to a certain nationality — **58 %** and **38 %** have a feeling of belonging to several nationalities.

**53 %** of respondents revealed unconscious ethnic prejudices (Table 3), thus they consciously or unconsciously pay attention to anthropological features. **16 %** of respondents revealed that if the behavior of the people around them seem unacceptable they are more likely to notice nationality and ethnicity.

A very significant percentage of the respondents 70 % indicated unconscious ethnic prejudices. On the basis of a quantitative analysis of the results it can be said that ethnic status is very significant for a large percentage of students — they feel their national identity and at the same time during interactions they feel and notice the differences of the other nationalities. Respondents revealed both consciously and unconsciously the existence of ethnic stereotypes and prejudices, which can lead to certain difficulties during adjustment.

Summing up the above it is becoming vivid that our first assumptions (that during the first year of study in an unfamiliar culture the students have the vivid ethnic self-identification and feel their cultural differences with other cultures) are true. Hypothesis 1 has been proved.

### 4.2. Conclusion two

During content analysis it was revealed that the CSH of first year foreign students possess the following peculiarities: situations which call forth some anxiety and misunderstanding, mainly affective component of adjustment, are mostly situational and unpredictable because they appear in uncertain circumstances, they are fixed but interpreted and explained in terms of cultural traditions. That is why they are characterized by the perception of students who are tolerant. The distinctive feature of foreign and local (Estonian) student perceptions of these uncomfortable situations is correlated with various sources of stress. As it was mentioned above foreign students consider them as occasional situations and do not fix on the sources.

Local students have immediate reactions to these situations which are projected to the party believed to have triggered the situation and they assign the cause to that party. They either easily project them to someone else or they can also accept that they are themselves



the cause of intolerance in this situation. Researching CSH of foreign students has revealed that the manifestation of intolerant behavior in mostly everyday situations and do not touch spiritual spheres and deeper aspects of personality. The further development of CSH keeps the path of integration directed in a way that is considered more positive.

During the analysis and interpretation of the described situations the components of ethnic settings, used in these situations, have been filtered out. The analysis highlighted that the affective component typically emphasized is associated with feelings, attitudes and anxieties.

The situations scrutinized mostly are connected with every-day life situations, in other words the respondents feel uncomfortable in circumstances related to food, clothes and satisfaction of basic necessities of life. Spiritual intolerance has not been displayed. There is no special stress or uncomfortable feelings in situations of public behavior, personal space, typical models of demonstration of attitudes and interrelations.

During the first year of studies cross-cultural shock can be seen or expressed at the surface level and doesn't have complicated forms because it concerns only their concentration of cognitive level and emotional level. Thus cultural shock at this stage does not take the form of deep stress or emotional disruption. According to M. Bennet's model this is one of the first stages of the development of the cultural shock syndrome[13]. Bennet says that the problem of culture shock is considered in the context of the so-called U-shaped curve of the process of adaptation, which includes three main stages: the first is characterized by enthusiasm and high spirits; the second by frustration, depression and confusion; and the third stage there gradually appears a sense of confidence and satisfaction. According to W. B. Gudykunst and Y. Y. Kim it is not possible for a person to enjoy an unending "honeymoon" period during a stay in a foreign country meaning that at some point feelings of uneasiness are unavoidable[14].

There is an important difference in the flow process adaptation and its length — from several months up to 4–5 years. But not all foreign students are beginning to stay in foreign country with ''honeymoon" and stage of depression is not versatile.

According to M. Bennet's model culture shock has specific features for first year students studying in the Estonian culture. The specific characteristics and features of foreign students as opposed to those of the new culture they are interacting in have a cohesive effect on adaptation. Individuals with similar cultures often come into contact with the locals, and, therefore, were less susceptible to culture shock (for example, Finnish students and students of post-Soviet countries).

This hypothesis (Hypothesis 2) was proven to be true by this research project.

### 4.3. Conclusion three

After the correlation analysis the ethnic identification was researched indicating a correlation between the age of students and definite identity with nationality or ethnic group (the older the student the less likely they are to identify themselves with any nationality). (Appendix 1, Table 1).

It was revealed that the one`s national identification is weakened when the person's self-identification is European.

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[13] *Bennet M.* (ed.) (1998). Basic Concepts of Intercultural Communication: Selected Readings. Yarmouth, Maine, Intercultural Press, Inc.

[14] *Gudykunst W. B. and Kim Y. Y.* (2003). Communicating with Strangers: An approach to International Communication. 4th ed. New York: Mcgraw-Hill.

The more countries visited the higher the level of attention fixated on the anthropological features others: in other words there is a higher level of hidden ethnic prejudice.

Researching the correlations between the components of cultural adjustment and CSH components the vivid correlations have not been revealed, except the following: the influence of age on traditionalism, influence of ethnic self-identification on intercultural tolerance or different forms of intolerance, influence of language and manner differences on polar component tolerance/intolerance:

*Tradition-Age p = -0.452*

*Tolerance-Gestures significant p = 0.342*

*Hiden intolerance — Citizen of the world p = 0.444*

*Open intolerance — Language p = 0.716*

*Case — Identification with your nationality p = 0.439*

Thus we can draw the conclusion that the Tolerance Disposition in connection with another culture inversely fixes the differences in cultures, by describing other people`s peculiar behavior as due to how one reacts to perceiving different cultural traditions and if to think about it from a point of predictability it does not influence the multiplication of uncomfortable situations (in reverse correlation *Tolerance — Fan)* it does not deepen contention and they are passively accepted as typical to the culture's traditions. (Appendix 2, Table 2).

Intolerant attitude to other cultures influences the extend of CSH. The additionally revealed connections are attached in Appendix 3.4. Our supposition that there is correlation (Hypothesis 3) between components of cultural adjustment and CSH components has been proved but in the beginning of research it expected to be higher.

## 5. Recommendations

Culture shock can be considered as an unpleasant and extreme reaction during the common process of adaptation to new conditions. But in spite of the stress the person adjusting to new cultures is becoming enriched and more developed due to enhanced cultural knowledge and competence. Since the 1990s this common experience is typical to people and is often identified as 'acculturative stress' (Berry 2006: 43) rather than culture shock[15].

**5.1.** The enlargement of the European Union has influenced the ethnic diversity of students at Estonian educational institutions and the educational environment is becoming more and more multicultural. These changes have a great impact on both the teaching and studying processes. Thus, the aims of education have to reflect the current situation in the educational environment. In light of internationalization increasing cross-cultural competence has to be an integral part of the university's plan for effectively managing internationalization. This demands the training of future specialist in cross-cultural communication and the university must consider implementing procedures to manage the consequences of culture shock. The combination of didactic and empirical methods of teaching can be very effective if the teachers are familiarized with studies on building cross-cultural competence. In the curriculum of the Institute of International Relations (a part of the Economic Department) we have tried to put into practice cross-cultural communication strategies for combining didactic and empirical methods of teaching. The knowledge received by the students during the lectures has been transferred and practiced in practical trainings, where practical skills of communication, understanding cultural differences and avoiding conflict situations have been formed.

[15] *Berry J. W.* (2006). Stress perspectives on acculturation // The Cambridge Handbook of Acculturation Psychology. Cambridge: Cambridge University Press.



According to Ting-Toomey without appropriately facilitating the student's adjustment process to studying in a foreign cultural context students are more likely to experience a prolonged period of feeling confusion over values, norms, processes as well as over content, identity, relational and procedural issues[16]. On the other hand, as Ting-Toomey points out careful attention to the adjustment process of students studying in this culture helps them to have not only a better learning experience but helps them to grow (mature) as individuals as a result of an enriching cultural experience.

**5.2.** Improving the performance of students attending higher education programs in Estonia demands attending to the factors involved in their adjustment to the Estonian cultural context. Experts in intercultural communications point out that for the university system as a whole to be competent in facilitating the cultural shock of international students those responsible for the program must be able to "Foresee and calculate the adjustment needs of students, and make certain assumptions as to how students will both approach and understand this culture and this cultural context."[17]

**5.3.** Estonian institutions of higher education increase the effectiveness of their effort to appeal to international students and their ability to offer an enriching learning experience by carefully planning the internationalization of its programs. This includes taking culture shock as an adjustment factor in the learning experience into consideration.

## Summary

The research project revealed that foreign students studying at this university are experiencing adjustment challenges during the early periods of studying in Estonia that have some features of culture shock. This finding corresponds with the results of similar research analyzing the adjustment challenges of international students[18]. The thriving of education for foreign students at TUT is based on its ability to effectively manage the internationalization of its higher educational systems. This means that to be competitive in the higher education market, where internationalization is a priority for most universities, the quality of the international program must be increased. In this respect, to enhance the learning experience of international students the university administration must be mindful of helping international students by facilitating their adjustment to studying in a new cultural context.

The challenge students face in adjusting to the new cultural context is defined as cultural shock. Cultural shock can result in any number of unpleasant feelings and emotions causing unpleasant interactions and experiences. This all leads to poorer results in the learning experience, on the one hand, and perhaps a bad reputation for the university on the other.

The research team used a very sophisticated tool for measuring the extent of culture shock and found evidence that by taking certain factors (that would contribute to improving

[16] *Ting-Toomey S.* (1999). Intercultural Conflict Management: A Mindful Approach. Communicating Accross Cultures. New York: Guilford Press. 194 p.

[17] *Lewis R.* (1996) When Cultures Collide. London: Nicholas Brealey, 2.

[18] *Thomson G. Rosenthal D. & Russell J.* Cultural Stress among International Students at an Australian University. Australian International Education Conference 2006, 7.

the university's overall intercultural competence) into consideration cultural shock can be reduced and the student will have a better adjustment to studying in the international program at Tallinn University of Technology. In this respect the test responses can be regarded as an indication that the university must pay more attention to the needs of the international students by better managing the internationalization of its programs. In other words university administrators cannot just assume that it is the responsibility of the student to manage the adjustment process. Effectively managing the internationalization of higher education means that the university must share in this responsibility and in addition the international program must be better integrated with the overall university program.

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## Appendix 1

Table1

The results of correlation analysis of researching the student`s ethnic self-identification according to Spearman's rho

| | | Number of countries visited | Citizen of the world | European | With your nationality | With a cultural group (nation) | Who you identify yourself with? | Feeling of belonging to any nationality | My identification of other people |
|---|---|---|---|---|---|---|---|---|---|
| Age | Correlation Coefficient | 0.194 | 0.003 | 0.012 | -0.143 | -0.307 | -0.115 | 0.153 | 0.12 |
| | Sig. (2-tailed) | 0.135 | 0.981 | 0.928 | 0.272 | 0.016 | 0.378 | 0.238 | 0.357 |
| **Number of countries visited** | **Correlation Coefficient** | **1** | **0.038** | **0.126** | **0.034** | **-0.173** | **-0.258** | **-0.109** | **0.254** |
| | Sig. (2-tailed) | | 0.769 | 0.334 | 0.796 | 0.184 | 0.045 | 0.405 | 0.049 |
| **Citizen of the world** | Correlation Coefficient | | 1 | 0.06 | -0.137 | -0.089 | 0.029 | 0.195 | 0.114 |
| | Sig. (2-tailed) | | | 0.646 | 0.291 | 0.496 | 0.822 | 0.132 | 0.383 |
| **European** | **Correlation Coefficient** | | | 1 | -0.29 | -0.107 | -0.099 | 0.124 | -0.115 |
| | Sig. (2-tailed) | | | | 0.024 | 0.41 | 0.45 | 0.341 | 0.379 |
| **With your nationality** | Correlation Coefficient | | | | 1 | 0.024 | -0.118 | -0.236 | 0.001 |
| | Sig. (2-tailed) | | | | | 0.857 | 0.365 | 0.067 | 0.996 |
| **With cultural group (nation)** | **Correlation Coefficient** | | | | | 1 | 0.206 | -0.002 | 0.048 |
| | Sig. (2-tailed) | | | | | | 0.112 | 0.985 | 0.715 |
| **Who you identify yourself with?** | **Correlation Coefficient** | | | | | | 1 | 0.033 | -0.182 |
| | Sig. (2-tailed) | | | | | | | 0.8 | 0.159 |
| **Feeling of belonging to any nationality** | Correlation Coefficient | | | | | | | 1 | -0.119 |
| | Sig. (2-tailed) | | | | | | | | 0.359 |

## Appendix 2

Table 2
Correlation Analyze 2

| | Affective | Cognitive | Constantive | Counsens | Uncounsens | Traditions | Subject | Object | Case | Obctace | Vector | Fan | Open intolerance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Traditions | 0,514 | 0,267 | 0,099 | -0,379 | -0,527 | 1 | -0,25 | 0,029 | 0,719 | 0,347 | 0,411 | -0,198 | . |
| | 0,009 | 0,178 | 0,601 | 0,036 | 0,005 | . | 0,168 | 0,878 | 0 | 0,096 | 0,037 | 0,304 | . |
| Subject | -0,322 | -0,101 | 0,366 | 0,236 | 0,297 | -0,25 | 1 | -0,091 | -0,221 | 0,093 | -0,025 | 0,271 | 0,358 |
| | 0,089 | 0,588 | 0,026 | 0,16 | 0,093 | 0,168 | . | 0,608 | 0,202 | 0,63 | 0,889 | 0,116 | 0,025 |
| Obctace | 0,335 | -0,067 | 0,266 | 0,071 | -0,002 | 0,347 | 0,093 | -0,223 | 0,4 | 1 | -0,58 | -0,263 | -0,234 |
| | 0,148 | 0,756 | 0,18 | 0,724 | 0,994 | 0,096 | 0,63 | 0,285 | 0,035 | . | 0,004 | 0,203 | 0,222 |
| Vector | 0,344 | 0,035 | -0,05 | -0,04 | 0,089 | 0,411 | -0,025 | 0,107 | 0,482 | -0,58 | 1 | -0,258 | -0,01 |
| | 0,092 | 0,861 | 0,79 | 0,832 | 0,64 | 0,037 | 0,889 | 0,581 | 0,008 | 0,004 | . | 0,177 | 0,957 |
| Fan | -0,323 | -0,125 | 0,33 | 0,195 | 0,042 | -0,198 | 0,271 | 0,358 | -0,213 | -0,263 | -0,258 | 1 | 0,56 |
| | 0,101 | 0,534 | 0,053 | 0,276 | 0,827 | 0,34 | 0,116 | 0,048 | 0,243 | 0,203 | 0,177 | . | 0 |
| Open intolerance | . | -0,101 | 0,272 | 0,623 | -0,1 | . | 0,358 | . | -0,093 | -0,234 | -0,01 | 0,56 | 1 |
| | . | 0,589 | 0,103 | 0 | 0,581 | . | 0,025 | . | 0,594 | 0,222 | 0,957 | 0 | . |
| Hiden intolerance | -0,236 | 0,253 | 0,207 | -0,107 | -0,208 | 0,045 | -0,058 | 0,28 | 0,051 | 0,068 | -0,237 | 0,386 | -0,058 |
| | 0,267 | 0,234 | 0,255 | 0,567 | 0,299 | 0,826 | 0,754 | 0,15 | 0,79 | 0,753 | 0,243 | 0,035 | 0,754 |
| Tolerance | 0,5 | 0,328 | -0,086 | -0,156 | 0,126 | 0,646 | -0,168 | -0,212 | 0,725 | 0,534 | 0,437 | -0,458 | -0,38 |
| | 0,006 | 0,077 | 0,625 | 0,372 | 0,501 | 0 | 0,321 | 0,243 | 0 | 0,004 | 0,012 | 0,007 | 0,02 |
| Spiritsfear | -0,223 | -0,07 | 0,322 | -0,066 | 0,299 | -0,052 | -0,047 | 0,477 | . | . | 0,117 | -0,053 | -0,038 |
| | 0,244 | 0,707 | 0,052 | 0,699 | 0,091 | 0,777 | 0,777 | 0,004 | . | . | 0,518 | 0,764 | 0,82 |
| Conventional | 0,199 | 0,483 | -0,134 | 0,336 | -0,266 | 0,079 | 0,092 | -0,169 | 0,233 | 0,152 | 0,013 | 0,076 | 0,162 |
| | 0,3 | 0,006 | 0,429 | 0,042 | 0,135 | 0,668 | 0,579 | 0,339 | 0,177 | 0,43 | 0,941 | 0,663 | 0,323 |



## Appendix 3

Table 3. Correlation Analyze 3

| | | Age | Citizen of the world | With your nationality | Who you identify yourself with? | My identification of other people | Gesture signifies | Language | Customs | conotative | Uncounsens | Traditions | Subject | Object | Case | Obstade | Fan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Affective | -0,229 | 0,053 | 0,175 | -0,113 | 0,491 | 0,159 | . | -0,223 | -0,667 | -0,256 | 0,514 | -0,322 | -0,145 | 0,642 | 0,335 | -0,323 | |
| | 0,231 | 0,786 | 0,365 | 0,56 | 0,007 | 0,41 | . | 0,244 | 0 | 0,228 | 0,009 | 0,089 | 0,462 | 0 | 0,148 | 0,101 | |
| Traditions | -0,451 | 0,051 | 0,344 | -0,088 | 0,422 | 0,424 | . | -0,052 | 0,099 | 0,527 | 1 | -0,25 | 0,029 | 0,719 | 0,347 | -0,198 | |
| | 0,01 | 0,782 | 0,054 | 0,633 | 0,016 | 0,015 | . | 0,777 | 0,601 | 0,005 | . | 0,168 | 0,878 | 0 | 0,096 | 0,304 | |
| Subject | -0,052 | 0,016 | -0,064 | -0,386 | -0,179 | -0,123 | -0,047 | -0,047 | 0,366 | 0,297 | -0,25 | 1 | -0,091 | -0,221 | 0,093 | 0,271 | |
| | 0,753 | 0,923 | 0,698 | 0,015 | 0,276 | 0,455 | 0,777 | 0,777 | 0,026 | 0,093 | 0,168 | . | 0,608 | 0,202 | 0,63 | 0,116 | |
| Case | -0,286 | -0,062 | 0,439 | 0,039 | 0,236 | 0,396 | -0,093 | . | 0,023 | -0,314 | 0,719 | -0,221 | -0,234 | 1 | 0,4 | -0,213 | |
| | 0,096 | 0,724 | 0,008 | 0,823 | 0,172 | 0,018 | 0,594 | . | 0,898 | 0,097 | 0 | 0,202 | 0,206 | . | 0,035 | 0,243 | |
| Obstacle | 0,185 | -0,175 | 0,054 | 0,111 | 0,264 | 0,117 | -0,234 | . | 0,266 | -0,002 | 0,347 | 0,093 | -0,223 | 0,4 | 1 | -0,263 | |
| | 0,338 | 0,364 | 0,782 | 0,568 | 0,166 | 0,544 | 0,222 | . | 0,18 | 0,994 | 0,096 | 0,63 | 0,285 | 0,035 | . | 0,203 | |
| Vector | -0,37 | -0,112 | 0,116 | -0,121 | 0,101 | 0,248 | 0,117 | -0,138 | -0,05 | 0,089 | 0,411 | -0,025 | 0,107 | 0,482 | -0,58 | -0,258 | |
| | 0,034 | 0,536 | 0,521 | 0,503 | 0,576 | 0,163 | 0,518 | 0,444 | 0,79 | 0,64 | 0,037 | 0,889 | 0,581 | 0,008 | 0,004 | 0,177 | |
| Fan | 0,056 | 0,424 | -0,047 | -0,013 | -0,19 | -0,139 | . | 0,56 | 0,33 | 0,042 | -0,198 | 0,271 | 0,358 | -0,213 | -0,263 | 1 | |
| | 0,748 | 0,011 | 0,791 | 0,943 | 0,275 | 0,425 | . | 0 | 0,053 | 0,827 | 0,304 | 0,116 | 0,048 | 0,243 | 0,203 | . | |
| Open intolerance | -0,218 | 0,09 | 0,127 | -0,311 | 0,166 | -0,099 | 0,716 | -0,038 | 0,272 | -0,1 | . | 0,358 | . | -0,093 | -0,234 | 0,56 | |
| | 0,183 | 0,584 | 0,442 | 0,054 | 0,312 | 0,548 | 0 | 0,82 | 0,103 | 0,581 | . | 0,025 | . | 0,594 | 0,222 | 0 | |
| Hiden intolerance | 0,11 | 0,444 | -0,022 | 0,233 | -0,318 | 0,111 | -0,058 | 0,596 | 0,207 | -0,208 | 0,045 | -0,058 | 0,28 | 0,051 | 0,068 | 0,386 | |
| | 0,548 | 0,011 | 0,903 | 0,2 | 0,076 | 0,544 | 0,754 | 0 | 0,255 | 0,299 | 0,826 | 0,754 | 0,15 | 0,79 | 0,753 | 0,035 | |

## Appendix 4

**Test 1. "WHO AM I?"**

(check which level you identity with the following

| | Most likely | To a certain degree | Not at all |
|---|---|---|---|
| citizen of the world | | | |
| European, | | | |
| With your nationality | | | |
| With an ethnic or cultural group with your nation (subnational) | | | |
| Who you identify yourself with? | | | |

Underline the correct answer:

**1. Do you notice the nationality of people around you?**

Usually, I do not

I do, if I dislike like them

I do regardless of my likes or dislikes

**2. Do you feel that you belong to any nationality, with the language, customs and traditions**?

No, I do not associate with any nationality

I feel that I belong to several nationalities

Yes, I do — to a certain nationality

**Test 2. "CULTURE SHOCK" (CSH)**

Cultures all have different ways of looking at reality. By this we mean that each culture has its own worldview which determines its values. There is sometimes the problem of judging another culture by one's own worldview thus being what is called ethnocentric. At worst different can mean wrong and at best the different can make a person uncomfortable. But invariably individuals have so much trouble adjusting to another culture that seems strange that we use the term CULTURE SHOCK to describe the phenomena. To transcend the differences and improve on our cultural interactions, we must find ways to become more culturally competent.

PLEASE, would you like to volunteer three or more examples of your own experiences of CULTURE SHOCK, occasions (in Estonia), when you were surprised or embarrassed to discover that people « don't do that here» or do things differently in a new setting. All possible topics are: food and dress preferences, gesture signifies, manners, personal space, expressions distance,most types of mind,problem solving styles,funny life events or confuses,basic life things, and so on

*Answer Sheet*

Your name_____date_____

Age_____sex_____country_____(state)_____

Countries you visited before_____

_____

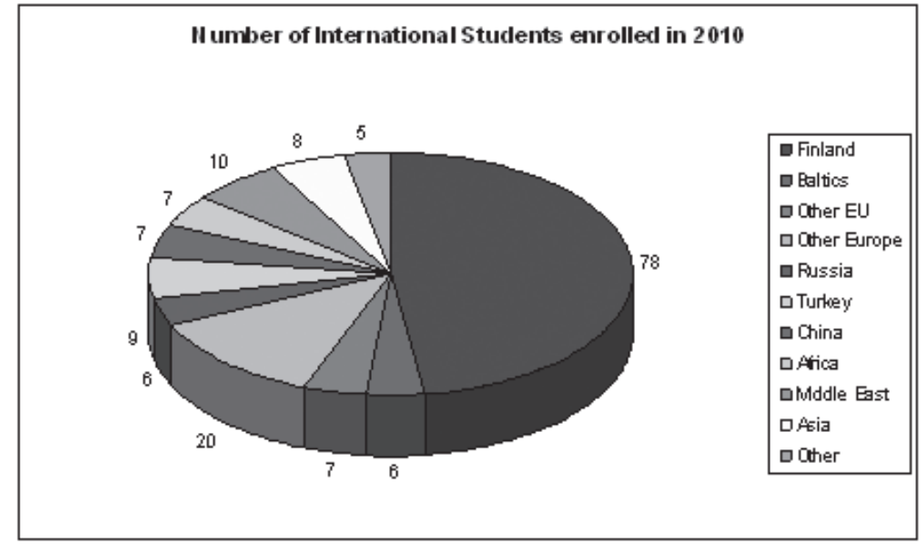
Topic 1. (Title)_____

Topic 2. (Title)_____

Topic 3. (Title)_____



## Appendix 5



# ИЗ АРХИВА НАУКОВЕДЕНИЯ

*Михаил Константинович Петров*
*(1924–1987)*

## Время как чистая форма чувственного созерцания, единство апперцепции и человекоразмерная характеристика истории научного познания

Триста лет назад, приступая к обоснованию трансцендентальной эстетики, науки обо всех принципах чувственности, Кант тут же сопроводил свое начинание сноской: «Только одни немцы пользуются теперь словом *эстетика* для обозначения того, что другие называют критикой вкуса. Под этим названием кроется ошибочная надежда, которую питал превосходный аналитик Баумгартен, — подвести критическую оценку прекрасного под принципы разума и возвысить правила ее до степени науки» (Кант, 1964: 128). Подобная «отметка времени» с привлечением очередных «баумгартенов» обнаруживается в любых попытках реконструировать систему кантовского априоризма, привести ее в рабочее состояние в меняющихся условиях научного познания, как если бы «Критика чистого разума» и в самом деле достигла в какой-то степени объявленной цели: «Метафизика, выраженная в понятиях, которые мы здесь дадим, — единственная из всех наук, имеющая право рассчитывать за короткое время при незначительных, но объединенных усилиях достигнуть такого успеха, что потомству останется только все согласовать со своими целями на *дидактический* манер без малейшего расширения содержания. Ведь это есть не что иное, как систематизированный *инвентарь* всего, чем мы располагаем благодаря *чистому разуму*» (Кант, 1964: 80).

Ниже мы попытаемся показать, что секрет живучести «Критики чистого разума», постоянного и активного участия априоризма Канта как в развитии философии, так и в становлении организационной структуры современной науки кроется как раз в том, что Кант называл изменением точки зрения, точки отсчета, проводя аналогию с Коперником: «До сих пор считали, что всякие наши знания должны сообразоваться с предметами. При этом, однако, кончались неудачей все попытки через понятия



что-то априорно установить относительно предметов, что расширяло бы наше знание о них. Поэтому следовало бы попытаться выяснить, не разрешим ли мы задачи метафизики более успешно, если будем исходить из предположения, что предметы должны сообразоваться с нашим познанием, — а это лучше согласуется с требованием возможности априорного знания о них, которое должно установить нечто о предметах раньше, чем они нам даны. Здесь повторяется то же, что и с первоначальной мыслью Коперника: когда оказалось, что гипотеза о вращении всех звезд вокруг наблюдателя недостаточно хорошо объясняет движения небесных тел, то он попытался установить, не достигнет ли он большего успеха, если предположить, что движется наблюдатель, а звезды находятся в состоянии покоя» (Кант, 1964: 87).

Прежде всего, нам следует выявить точку зрения и точку отсчета тех, «которые до сих пор считали, что всякие наши знания должны сообразоваться с предметами». «Коперниковский переворот» связан в основном с переосмыслением статуса и порядка следования постулатов: «Ибо то, что необходимо побуждает нас выходить за пределы опыта и всех явлений, есть *безусловное*, которое разум необходимо и вполне справедливо ищет в вещах в себе в дополнение ко всему обусловленному, требуя, таким образом, законченного ряда условий» (Кант, 1964: 89). Поэтому для понимания позиции предшественников и смысла совершенного Кантом переворота первостепенное значение имеет анализ вполне конкретного «законченного ряда условий», берущего начало от «безусловного» — абсолюта, который был выработан в прошлом и признавался современниками Канта.

До предшественников и современников Канта, как и до самого Канта, его ближайших критиков, исследователей и последователей, этот «законченный ряд условий» доходил в составе объединенной парадигмы всех видов интеллектуальной деятельности — богословие, юриспруденция, медицина, «свободные профессии», включая и возникающие научные. Унифицированная парадигма осваивалась в процессе университетской подготовки, а она во всех университетах Европы строилась по единой организационной схеме: общеобязательный подготовительный факультет (факультет «свободных искусств», с XVI века чаще — «философский» факультет), программы подготовки которого включали, кроме знания древних языков — сначала латыни, а затем и греческого, — тривий (грамматика, диалектика и риторика) и квадривий (арифметика, музыка, геометрия и астрономия), и три специализирующих «высоких» факультета — богословский, юридический, медицинский (Петров, 1979). С небольшими модификациями схема воспроизводилась в подготовке интеллектуалов Европы с XII века практически до середины XIX века, когда в разных странах и с разной интенсивностью она стала вытесняться господствующей ныне во всех развитых странах европейской культурной традиции схемой, предполагающей действие законов о всеобщем и обязательном образовании по единым для всего взрослеющего населения страны программам общеобразовательной средней школы с 10–11-летним сроком обучения формальными методами, основанными на всеобщей грамотности и едином общеобязательном наборе текстов-учебников.

Обозначим через $T_u$ и $T_y$ эти два способа приобщения индивидов к «законченному ряду условий», владение которым обеспечивает в процессе познания выход «за пределы опыта и всех явлений» ради умножения человеческих знаний, пополнение наличных и освоенных знаний новыми. Различение $T_u$ и $T_y$ призвано подчеркнуть связь «законченного ряда условий» не только с процессами познания, где этот ряд условий, благоприобретенный индивидами в возрастном воспитательном движении,

выступает в роли рабочего априоризма, *парадигмы*, ориентирующей и организующей комплекс познавательных действий индивида в поисках нового знания, но и с процессами коммуникации, где тот же ряд условий выступает в роли канона представления результатов индивидуального поиска в форме, обеспечивающей достижение взаимопонимания в группе индивидов — активных агентов процесса познания, — передачу ими результатов индивидуального поиска в групповое, общенаучное и общесоциальное достояние.

$T_u$ и $T_y$ тождественны с точки зрения формально-когнитивной техники обучения взрослеющих индивидов, ввода их во владение «законченным рядом условий». Эта техника — учитель, ученик, учебник, учебная литература, урок, лекция — возникала и отрабатывалась в системе подготовки интеллектуальных кадров и без особых изменений дошла до нашего времени. Но $T_u$ и $T_y$ существенно отличаются друг от друга как по составу обязательного для освоения, включенного в учебники материала, образующего *тезаурус* группы, концептуально-понятийную базу достижения взаимопонимания между теми, кто владеет соответствующим «законченным рядом условий» $T_u$ или $T_y$, так и по составу социальных групп, организуемых этими «законченными рядами условий» в единые системы коммуникации, в когнитивно-социальные сообщества.

$T_u$ — тезаурус интеллектуалов, предполагающий знание тривия и квадривия, древних языков и довольно жесткого круга работ античных и средневековых авторов, — был «языком» довольно пестрой, по современным критериям, социальной группы, принадлежность к которой определялась не столько профессиональными или социоэкономическими критериями, сколько особым юридическим статусом будущих членов интеллектуального сообщества в санкционированной церковью практике наследования социальных статусов, привилегий и обязанностей глав семей. Их наследовал старший сын, и в большинстве своем интеллектуалами были либо младшие сыновья из обеспеченных, иногда и знатных семей, либо «бастарды» — незаконные сыновья глав семей или самих интеллектуалов, на значительную часть которых, особенно на духовенство и на членов университетских академических сообществ, распространялся целибат, запрет иметь семью. С точки зрения его воспроизводства, интеллектуальное сообщество было привилегированной и сравнительно малочисленной частью более широкой группы «лишних людей», которая в массовом порядке воспроизводилась в странах Европы в результате совокупного воздействия права первородства и церковного запрета на все виды контроля над рождаемостью.

Подавляющая часть «лишних людей» Европы была на «свободном распределении», то есть представляла собой активную, подготовленную в семейном длительном воспитательном контакте со старшими рабочую силу, которая этим семейным образованием распределялась в признанную обществом номенклатуру видов деятельности, но в то же время и отсекалась от нее старшими братьями, ближайшими наследниками дела отца. Право первородства вынуждало «лишних людей» собственными силами искать места в жизни, изобретать способы укоренения в обществе, создавая собственную семью, свой «дом», свое «дело», которые вовсе не обязательно должны были принадлежать к тому виду деятельности, который практически осваивался в доме отца без когнитивно-формальной техники обучения. Этот вынужденный обстоятельствами появления на свет «трансцензус», выход «за пределы опыта» — высокая вероятность смены вида деятельности в личном плане



и умножение номенклатуры признанных видов деятельности в общесоциальном плане за счет активного поиска «лишними людьми» *новых* видов деятельности — придавал социальной группе «лишних людей» черты абстрактной, изобретательной, ищущей приложения силы, способной революционизировать традиционные номенклатуры деятельности, активно внедрять новое. В ряде стран предпринимались организованные на государственном уровне попытки утилизации творческого потенциала «лишних людей». В Пруссии, например, для всех детей образование стало номинально обязательным с 1717 года, за несколько лет до рождения Канта, что довольно быстро сделало Пруссию «страной школ и казарм» (Emergence, 1976: 180). Вполне возможно, что именно это обстоятельство открыло сыну ремесленника И. Канту путь в университет, в интеллектуалы.

Но в целом «трудоустройство» младших сыновей со времен Средневековья и до середины XIX века являлось либо частным делом, либо делом главы семьи, либо самих младших сыновей, так что путь в социализацию через университет был доступен главным образом выходцам из состоятельных семей. Роберт Бойль, например, — третий сын Ричарда, *первого* графа Корка, одного из авантюристов елизаветинских времен, который отправился искать счастья в Ирландию, где и основал династию, получил на средства отца обычное интеллектуальное образование в Швейцарии, так писал о своем статусе младшего сына: «То, что я не был старшим — счастье. Для человека, у которого нет наклонностей участвовать в отталкивающей суете мира, получить превосходство в знатной семье — позолоченная форма рабства. Первородство обязывает его вести сложный и публично признанный образ жизни, поддерживать престиж семьи, подавлять свои глубочайшие наклонности. Часто первородство вынуждает его выстраивать успехи дома на руинах собственного призвания» (Jacob, 1977: 81).

Основная часть «лишних людей» обеспечивала кадрами армию, флот, активно участвовала в различного рода войнах, завоеваниях, экспедициях, учреждении колоний, во всем том, что обычно вкладывают в понятие географической, политической и культурной экспансии Европы. Многое и в самой Европе, и за ее пределами совершалось на костях и крови «лишних людей», и в любом из таких предприятий обязательными спутниками и соучастниками были интеллектуалы, выпускники трех «высоких» факультетов — священники, медики, юристы. Едва ли не основное в системе Канта понятие трансцендентальности, выхода «за пределы опыта и всех явлений» исторически связано, похоже, и с острым чувством сопричастности к группе «лишних людей», и с соучастием интеллектуалов в экспансионистских предприятиях европейцев. В эпиграф «Критики чистого разума» вынесены слова из предисловия к «Великому восстановлению» глубоко чтимого Кантом Бэкона, хранителя большой печати Англии. В отличие от Бойля, Ф. Бэкон всю жизнь негодовал на несправедливость судьбы, лишившей его первородства. Сам Бэкон на титул первого издания «Нового органона» вынес строку из пророчества Даниила: «Многие пройдут, и многообразно будет знание». Бэкон, как и все участники революции интеллектуалов XVII века, постоянно обращался к этому пророчеству, усматривая в нем трансцендентальный смысл: «Дальние вояжи и путешествия явили глазу множество вещей в природе, которые могут бросить новый свет на человеческую философию и науку, проверить опытом мнения и заключения древних. Не только разум, но и пророчество соединяет то и другое. Что еще мог разуметь пророк, который, упоминая о последних временах, сказал: «Многие пройдут, и умножится знание»? Разве не то

он имел в виду, что прохождение или обход вокруг Земли и усиление или умножение наук были предопределены произойти в ту же самую эпоху и в то же самое столетие?» (Klaaren, 1977: 94–95).

В отличие от $T_u$, тезауруса интеллектуалов, который при всех его достоинствах единого языка общенаучной коммуникации и высоком статусе духовного интегратора европейской «церквоцентричной» культуры Средневековья и начала Нового времени был все же языком незначительной части социальной группы «лишних людей», $T_y$, универсальный тезаурус современного развитого общества, несет куда более ощутимую и резко выраженную нагрузку общесоциального интегратора, единого по концептуально-понятийной базе языка всех взрослых, какими бы специализированными видами деятельности они ни занимались. $T_y$, как и $T_u$, приобретается в возрастном движении и становится частью личной истории взрослого индивида на этапе, который непосредственно примыкает к началу осознанной его жизни, к этапу «от 2 до 5», на котором взрослеющие младенцы всех типов культуры, всех рас и национальностей осваивают и интериоризируют как непререкаемую данность естественный язык, ценности, нормы поведения социально-когнитивного окружения, где их угораздило родиться по воле родителей. Курс $T_y$, как и курс $T_u$, проходится «лингвистически взрослыми» индивидами, относительно которых взрослым воспитателям заведомо известно, что к ним в полном объеме применима формально-когнитивная техника обучения.

Но если в организованный идентичной техникой обучения курс $T_u$ подключилась лишь незначительная часть школьных возрастных групп, скажем, от 7 до 17 лет, из состава которых исключались женщины, старшие сыновья и все те, родители которых не были в состоянии или не имели желания нести расходы на образование, то курс $T_y$ в развитых странах проходят возрастные группы целиком с весьма малым отсевом по явным физическим и ментальным отклонениям от нормы. Именно эта тотальность прохождения $T_y$ всеми индивидами на школьном возрастном этапе, где естественная неотвратимость движения по возрастным группам организована формально-когнитивной техникой обучения в естественно-социальную необходимость воспитательного движения по единым учебникам, расписаниям, учебным планам к контрольно-пропускному пункту входа в специализирующую подготовку, к аттестату зрелости или к другому юридическому документу, которым подтверждается, что его владелец осилил курс универсальной подготовки $T_y$, имеет право продолжать движение во взрослое специализированное состояние по предлагаемому обществом выбору путей в специализацию, придает $T_y$ черты всеобщей базы взаимопонимания взрослых, которыми $T_u$ определенно не обладал.

Внешне это выражается в том, что все мы, кому за двадцать, без труда находим общий язык в любых ситуациях общения с первым встречным, с любой взрослой аудиторией, действуя по максиме: хочешь говорить понятно — говори на языке десятиклассника. Этот тезаурусный ранжир надежен: его используют не только все виды массовой коммуникации — печать, радио, телевидение, — но и сама наука, когда ученые пробуют сформулировать общенаучные цели, поговорить о научной политике или на междисциплинарные темы на любых уровнях от встреч в коридорах университета на перерывах до ежегодных собраний академий наук. Везде, где бы ни возникали такие попытки, немедленно включается замкнутый на $T_y$ непроходимый экран, пресекающий любые поползновения осмысленного общения между физиком, скажем, и лингвистом, биологом, химиком, и предлагается им вернуться



к языку абитуриентской юности, оставаться в рамках концептуально-понятийных ограничений, преподанных им в школе. В конце XIX века присутствие этого экрана начинает ощущаться и в нашем восприятии работ, в частности и «Критики чистого разума», написанных на $T_u$ интеллектуалами для интеллектуалов, причем строение этого экранирующего эффекта и возникающие по его поводу трудности, в общем-то, напоминают тот комплекс трудностей, который возник перед интеллектуалами с появлением опытной науки и дал начало ряду упоминаемых Кантом попыток осознать правила трансцендентального чтения «Книги природы» и выявить тезаурусную базу ее понимания.

Когда речь идет о ситуациях типа встреч преподавателей разных дисциплин в университетском коридоре или ученых на годичных собраниях академий наук, или даже встреч учителей на переменах в учительской, генезис и смысл разделяющего их экрана, который налагает табу на разговоры о науке в пределах храма науки, достаточно ясен. До аттестата зрелости все индивиды идут в своих группах единым предельно унифицированным путем, и в какой бы возрастной группе мы их ни заставали в момент наблюдения, их личные истории, отмеченные значением тезауруса $T_y$, подобны. Дальше начинаются расхождения и, соответственно, появляются тезаурусные лакуны, пресекающие попытки общения. Сегодня только в академическом секторе этих радиальных дорог, берущих начало от $T_y$ и ведущих через студенческую (4 года) и аспирантскую (3 года) подготовку к переднему краю научных исследований, более сотни (Научная деятельность, 1980: 71), а в неакадемическом секторе, где от $T_y$ идут дороги в виды деятельности, не требующие от взрослых университетского диплома и диплома о присвоении ученой степени, число специализирующих дорог вообще не поддается учету. В этих условиях обращение всех взрослых к $T_y$ как к единой концептуально-понятийной базе взаимопонимания выглядит не только вынужденным, но и спасительным для общества актом поддержания когнитивной целостности и социального единства живущего поколения в процессах умножения номенклатуры специализированных видов деятельности и растущей дифференциации проблемных областей научно-дисциплинарного познания мира.

Более сложной по генезису и строению представляет лакуна, возникающая сегодня между массивом научной литературы, написанном на $T_u$, и современными $T_y$ читателями и исследователями. Хронологические границы массива $T_u$ литературы, к которому принадлежит и «Критика чистого разума», определяются различно. Д. Найт, к примеру, считает, что эпоха действия $T_u$, когда статьи и книги писали для всего интеллектуального сообщества, завершается работами Сади Карно «Размышления» 1824 года и Гельмгольца «О сохранении силы» 1847 года (Development of science publishing in Europe, 1980: 24), тогда как до этого среди интеллектуалов господствовало взаимопонимание: «До 1850 года научные сообщества не были специализированы, так что в первой половине XIX века мужи науки понимали почти все, что появлялось в научных трудах и монографиях. Эту эпоху полного взаимопонимания завершил, пожалуй, Гельмгольц — медик по образованию, который в середине XIX века вел исследования по теоретической физике. Он, конечно же, гигант, но в предшествующий период подобная широта научных интересов никого не удивляла» (Development of science publishing in Europe, 1980: 23).

Для понимания хода мыслей интеллектуала Канта более продуктивна, видимо, граница $T_u$, прочерченная работой юриста Лайеля «Основы геологии» (1830–1833) и тесно примыкающей к ней работой теолога и медика Ч. Дарвина «Происхождение

видов» (1859), вокруг которых в конце XIX века развернулась длительная и, похоже, последняя «межфакультетская» дискуссия интеллектуалов, активными участниками которой были: Т. Гексли, епископ Уилберфорс, архиепископ Дублина Р. Уайтли, Дж. Лаббок, герцог Аджилл, Лайель, Тейлор, Бюхнер, Морган, Фиск (Gillespie, 1977: 40–56). Именно в этой дискуссии 60–70-х годов XIX века завершилась, по нашему мнению, та перестановка составляющих «конечного ряда условий», которую предложил в конце XVIII века Кант, что перевело $T_u$ в статус рудимента и открыло дорогу независимому от $T_u$ развитию $T_y$, вытеснению текстов $T_u$ набором текстов $T_y$, которые оказались для науки постоянно действующим инструментом «онаучивания» общества через изменение текстов учебников общеобразовательной средней школы, производное от событий на переднем крае научного познания мира.

Сегодня попасть в мир $T_u$ понятий и представлений сложно не только потому, что существует серьезное различие между $T_u$ и $T_y$ — оно действительно существует и для любого фиксированного момента времени может быть выявлено как вполне конкретное различие простым сравнением обязательных для освоения учебных программ и обеспечивающих наборов текстов-учебников, но также и потому, что все разновидности программ и учебных курсов $T_u$ сегодня мертвы, оставлены проходившими по ним когортами студентов, лицеистов, гимназистов, бурсаков, учеников церковно-приходских школ в том конечном состоянии, по которому прошли арьергарды. Но $T_y$ жив и изменчив, на него ежегодно вступает новая группа первоклассников, чтобы в десятилетнем марше по неделям, четвертям, классам пройти к выпускным экзаменам, получить аттестат зрелости и решить, куда из сотен возможных адресов двигаться во взрослую жизнь.

Жестко определенная по длительности и календарным датам годичная периодичность школьного воспитательного движения, когда, скажем, 1 сентября все школы торжественно встречают первоклассников, а 26 июня столь же торжественно провожают десятиклассников, превращает общеобразовательную среднюю школу в постоянно действующий синхронизатор естественного возрастного движения, который упорядочивает и по времени и по фазе становление личных историй всех индивидов на всем участке их движения от колыбели до специализированных терминалов взрослой деятельности. Иными словами, законы о всеобщем и обязательном образовании превращают естественное возрастное движение, подчиненное биокоду человека, в основание интеграции, а формально-когнитивная техника обучения структурирует это основание, сообразуясь с возрастными значениями физических и ментальных способностей человека, в когнитивно-социальную целостность, в устойчивую автономную и самодовлеющую систему воспитания, которая хотя и сдвигается ежегодно вверх по потоку взрослеющих индивидов, чтобы поглотить очередную группу созревших первоклассников и освободить место для десятиклассников, остается в таких скачкообразных ежегодных сдвигах, открывающих дорогу в следующий класс тем, кто прошел предыдущий, целостностью во времени со строго определенным по составу участников (учитель — класс) и по тезаурусной характеристике смыслом микрособытий (уроков) в любой точке этого целостного временного континуума. Точно такая же синхронизированная, с опорой на предписанную биокодом неотвратимость возрастного движения, с «кареточным», как у машинки, годовым сдвигом структура целостности обнаруживается на постшкольных, организованных когнитивной техникой специализирующих этапах, вплоть до прибытия повзрослевших за время движения по классам и курсам индивидов к местам их взрослой деятельности.



Наблюдаемый на периоде от входа в школу до входа в специализированный вид взрослой деятельности униформизм структуры — все организованные формально-когнитивной техникой периоды возрастного унифицирующего (школьный) и специализирующего (постшкольный) движений образуют собой конечные по числу и жестко упорядоченные по следованию наборы актов общения (уроков, лекций, занятий), в которых каждый последующий акт предполагает пройденными все предыдущие и каждый такой акт воспроизводится раз в год на тех же условиях для новой по составу группы индивидов, — придает таким конечным последовательностям ассоциированных в целостность актов, с одной стороны, жесткость — число актов в последовательности не может не расти (не только социальный интерес, но и программы биокода фиксируют сроки прохождения по этапам, превращая постоянные попытки изменить их деятельность в ограниченный по результатам поиск одинакового сочетания биологической и социальной программ формирования взрослых индивидов), а с другой стороны, этот униформизм структуры придает последовательностям гибкость, позволяет насыщать их новым содержанием за счет дренажа избыточного, устаревшего, неэффективного, если при этом не нарушаются два требования: а) сохранить неизменным срок обучения, то есть предусмотренных планом «часов» данной последовательности; б) сохранить тезаурусную преемственность актов речи или тех же «часов», включаемых в данную последовательность.

Первое требование, в общем-то, не нуждается в объяснениях. Здесь каждому взрослому, особенно если у него есть дети школьного возраста, все ясно: дети перегружены, нужны реформы, но при всех обстоятельствах, какие бы изменения ни произошли в программах средней школы, аттестат зрелости в числе признанных обществом прав должен содержать право на попытку поступать в университет, на выбор одной из радиальных специализирующих дорог к переднему краю научного познания в академическом секторе постшкольных специализирующих этапов движения в терминалы взрослой деятельности. В этих пределах — дети перегружены, а право поступать в университет должно быть сохранено — и мечется педагогическая мысль реформаторов и инициируемых ими публичных дискуссий вот уже около сотни лет, катализируя процесс изменений в составе текстов $T_y$, но не более того. Сам процесс изменений идет по другой линии, через воспитание воспитателей.

Необходимость сохранения стыковки $T_y$ именно с набором путей к переднему краю науки как раз и связана с требованием тезаурусной преемственности в ассоциированных рядах актов речи, которые формируют периоды возрастного движения, и это требование нуждается в пояснении. Проще всего это сделать на модели речевого общения, предложенной Соссюром. По этой модели акт общения — событие коллективное, «предполагает, по крайней мере, двух лиц — это минимум, необходимый для полноты ситуации» (Соссюр, 1977: 49). Ситуация всегда поляризована, в ней обязательно присутствуют *A* (говорящий, учитель, лектор, докладчик, автор) и *B* (слушающий, читатель, класс, аудитория): «Отправная точка акта речевого общения находится в мозгу одного из разговаривающих, скажем *A*, где явления сознания, называемые нами “понятиями”, ассоциируются с представлениями языковых знаков или с акустическими образами, служащими для выражения понятий. Предположим, что данное понятие вызывает в мозгу соответствующий акустический образ — это явление чисто *психического* порядка, за которым следует *физиологический* процесс: мозг передает органам речи соответствующий образу импульс, затем звуковые волны распространяются из уст *A* к ушам *B* — это уже чисто *физический* процесс. Далее процесс

общения продолжается в *B*, но в обратном порядке: от уха к мозгу — физиологическая передача акустического образа; в мозгу — психическая ассоциация этого образа с соответственным понятием. Когда *B* заговорит в свою очередь, во время этого нового акта речи будет проделан в точности тот же самый путь, что и во время первого, — от мозга *B* к мозгу *A* речь пройдет через те же самые фазы» (Соссюр, 1977: 49–50).

Для Соссюра, как и для большинства лингвистов, эта классическая модель служит целям перевода осмысленной речевой деятельности в наблюдаемое и доступное для научного изучения состояние по физической фазе в акустическом (волны от уст *A* к ушам *B*) или графическом (текст) оформлении. Связь психической, физиологической и физической фаз позволяет лингвистам выдвигать на правах условий осуществимости осмысленного акта речи два предположения: 1) *A* и *B* обладают тождеством тезаурусов — набором понятий, однозначно ассоциируемых с набором акустических или графических образов — слов; 2) *A* и *B* обладают тождеством грамматик — идентичным набором универсальных правил связи слов в осмысленные целостности — предложения. Крен в научность у Соссюра и у большинства лингвистов выражается в том, что модель акта речи лишена отметки времени, дается в диссоциированной самодовлеющей форме предметной единицы науки о языке того же ранга, что и предметные единицы типа атома, молекулы, клетки организма в других науках, что превращает тезаурусное и грамматическое тождества в необходимые и *достаточные* условия осуществимости речевой деятельности, существования предметной области науки о языке. Подчеркивая достоинства письменности, графической формы физической фазы акта, Соссюр пишет: «Именно возможность фиксировать явления языка позволяет сделать словарь и грамматику верным изображением его: ведь язык — это сокровищница акустических образов, а письмо обеспечивает им осязаемую форму» (Соссюр, 1977: 53).

Нам же на подходах к Канту важно понять трансцендентальный смысл тезаурусной преемственности, которую мы наблюдаем в организованных формально-когнитивной техникой периодах возрастного движения к конечным структурам рабочих априоризмов и особенно к тем из них, которые используются учеными на переднем крае для выхода за пределы известного, проверенного экспериментом. Для этого классическая модель Соссюра требует уточнений, раздельного анализа условий на «входе» в стандартную ситуацию общения между *A* и *B* и на «выходе» — завершении. Оба тождества — тезаурусное и грамматическое — сохраняют силу условий осуществимости и для начальных, и для конечных условий стандартной ситуации общения между *A* и *B*, но они различны как некоторая длительность ситуации, как когнитивно структурированный сдвиг по времени, как «объяснение», меняющее значение тождества тезаурусов *A* и *B* на фиксированном периоде времени — уроке, лекции, занятии, докладе, статье, письме и т. д. Если обозначить начальное тождество тезаурусов *A* и *B* через $T_o$, а конечное через $T_1$, то смысл событий, происходящих в стандартной ситуации общения между *A* и *B*, можно выразить как перевод силами *A* общего для *A* и *B* значения $T_o$ в новое для *B,* но известное *A* и до начала ситуации значение $T_1$. Иными словами, к принятым лингвистами двум условиям осуществимости акта речи — тезаурусное и грамматическое тождество *A* и *B* — добавляется несущее отметку времени третье, дополняющее два первых до достаточности: разность $T_1$ и $T_o$ отлична от 0 и положительна. Если эта разность равна 0, то *A* либо нечего сказать *B*, либо он уже сказал все, что имел сказать. Если разность отрицательна, акт речи обращается в нудную бессмыслицу повтора того, что уже известно *B*.



Это третье дополнительное условие осуществимости ситуаций общения между *A* и *B* есть, по сути дела, констатация их принадлежности к истории актов общения между *A* и *B*. В периодах воспитательного возрастного движения присутствие этого условия в форме тезаурусной преемственности очевидно: $T_1$ предшествующей ситуации общения между *A* и *B* становится $T_o$ последующей, и этот принцип ассоциации стандартных ситуаций общения между *A* и *B* (уроков, лекций, занятий) в целостность программ и курсов обучения используется как универсалия когнитивной техники оформления всех периодов возрастного движения унифицирующей и специализирующей природы, входящих в единую систему развода взрослеющих младенцев к местам их взрослой специализированной деятельности.

Но как только мы приходим к выводу, что в отличие от естественной поступательности взросления, которая регулируется унаследованным от родителей биокодом, предписывающим человеку независимые от него возрастные значения физических и, видимо, ментальных потенций, когнитивная поступательность движения во взрослое состояние обеспечивается принципом тезаурусной преемственности: $T_1$ предыдущей ситуации общения становится $T_o$ следующей, — мы оказываемся в эпицентре проблематики, вызванной к жизни коперниковским переворотом Канта.

Противопоставляя две позиции: а) «знания должны сообразовываться с предметами»; б) «предметы должны сообразовываться с нашим познанием» (Кант, 1964: 87) и подчеркивая трансцендентальную бесплодность первой и перспективность второй, Кант, как и большинство его ближайших предшественников и современников, имел в виду основанный на христианской идее творения мира — всеобщего начала всех историй, в том числе и истории человеческого познания, — синтез идей Платона и Аристотеля, представленный в «Сумме теологии» Фомы Аквинского (1273). По смыслу конструкции Фомы, мир сотворен по модели Платона, а предстает в познаваемой для человека форме по модели Аристотеля. Рабочая схема такого синтеза обнаруживается уже у Августина как триадное различение: ante rem — in rem — post rem, (до вещей — в вещах — после вещей), в котором предшествующий член выступает на правах условия осуществимости последующего. «До вещей» в этой схеме — план мира в уме бога до акта творения, «в вещах» — реализованный в акте творения мир вещей, за каждой из которых стоит архетип божественного плана, «после вещей» — познавательная позиция человека, сотворенного вместе с миром вещей по образу и подобию бога. Осмысление начала христианской истории, акта творения мира по Платону, а возможностей человеческого познания — по Аристотелю как раз и концентрировало внимание на отношениях истинности, выдвигая их в абсолют, в начало ряда условий осуществимости человеческого познания. Фома писал: «Истина в собственном смысле слова присутствует в интеллекте. Вещь же именуется истинной от истины, присутствующей в каком-либо интеллекте. Отсюда изменчивость истины должна рассматриваться в отношении интеллекта; истинность же последнего состоит в том, что он согласуется с постигнутыми вещами. Эта согласованность может изменяться в двояком направлении... Истина состоит в соответствии интеллекта и вещи, как то сказано выше. Но такой интеллект, который есть причина вещи, прилагается к вещи как наугольник и мерило (модель Платона, “до вещей”. — *М. П.*). Обратным образом обстоит дело с интеллектом, который получается от вещей. В самом деле, когда вещь есть мерило и наугольник интеллекта, истина состоит в том, чтобы интеллект соответствовал вещи, как то происходит в нас (модель Аристотеля, “после вещей”. — *М. П.*). Но когда интеллект есть мерило

и наугольник интеллекта вещей, истина состоит в том, чтобы вещь соответствовала интеллекту; так о ремесленнике говорят, что он сделал истинную вещь, когда она отвечает правилам ремесла» (Антология мировой философии, 1969: 837).

Ссылка Фомы на ремесленника как на свидетельство в пользу предсуществования мира в уме бога до акта творения обладала для интеллектуалов доказательной силой и авторитетом — за ней стоял Платон, его посылка божественного происхождения идей-образцов, организующих деятельность ремесленников: «Для каждого множества вещей, обозначаемых одним именем, мы обычно устанавливаем только один определенный вид... Кроватей и столов на свете множество... Но идей этих предметов только две — одна для кровати и одна для стола... И обычно мы говорим, что мастер изготовляет ту или иную вещь, всматриваясь в ее идею: один делает столы, другой кровати, нужные нам, и то же самое в остальных случаях. Но никто из мастеров не создает самое идею. Разве он это может? — Никоим образом» (Государство, 596 АВ).

Несколько сложнее обстояло дело с Аристотелем, у которого отношения истинности возникали не путем копирования слов-идей-образцов в деятельности, а в акте связи слов-понятий в предложения, в суждения о вещах. Но четкое различение Аристотелем первичных и вторичных сущностей, из которых первичная — единичная вещь, способная, оставаясь тождественной по числу, меняться, принимать противоположности, — могла быть только подлежащим в предложении, организующим его центром, как раз и создавала из сотворенной Платоном единичной вещи связующее звено перехода к отношениям истинности предложений-суждений: «Все другое (помимо первых сущностей) или говорится о первых сущностях как о подлежащих, или же находится в них как в подлежащих. Поэтому, если бы не существовало первых сущностей, не могло бы существовать и ничего другого» (Категории, 2 в).

«Мир сотворенных вещей», то, что «в вещах», становился в такой интерпретации и свидетельством в пользу присутствия в человеческом окружении разумной логической характеристики, и опорой «естественного благочестия» — веры в интеллектуальную мощь творца. Различные формулировки этого благочестия обнаруживаются и у предшественников Канта, и у самого Канта: «Достойный восхищения порядок, красота и предусмотрительность, проглядывающие во всем в природе, сами по себе должны породить веру в мудрого и великого *создателя мира*» (Кант, 1964: 97).

Поскольку этот великий создатель осмыслялся интеллектуалами в иерархии степеней качеств, почитаемых человеком — у Фомы пять таких доказательств бытия божьего (Кант, 1964: 828–831), пять иерархий, замкнутых на фигуре бога, а формы божественных творений осмыслялись по «книжным» формам творений интеллектуалов, уже где-то в XI–XII веках возникает образ «Книги природы», второго Писания, второй Библии, который лишь усиливал тот логико-лингвистический «категориальный» оттенок представлений о мире как упорядоченной целостности, который выражался постулатом Аристотеля: «Сколькими способами сказывается, столькими способами и означает себя бытие» (Метафизика, 1017 а).

Бэкон, например, писал: «И для того, чтобы мы не впадали в заблуждение, он дал нам две книги: “Книгу писания”, в которой раскрывается воля божья, а затем — “Книгу природы”, раскрывающую его могущество. Из двух книг вторая является как бы ключом к первой, не только подготовляя наш разум к восприятию на основе общих законов мышления и речи истинного смысла Писания, но и, главным образом, развивая нашу веру, заставляя нас обратиться к серьезному размышлению



о божественном всемогуществе, знаки которого четко запечатлены на камне его творений» (Бэкон, 1971: 128).

Концепт «Книги природы» обрел для интеллектуалов особую ценность в эпоху Реформации, когда он усилиями главным образом кальвинистов вошел в связь с пророчеством Даниила: «А ты, Даниил, сокрой слова сии и запечатай книгу сию до последнего времени; многие прочитают ее, и умножится ведение» (Даниил, 12, 4). Мы уже упоминали о том, что Кант берет эпиграфом слова Бэкона из предисловия к «Великому восстановлению», а Бэкон выносит на титул «Нового органона» латинизированный вариант последней строки: «многие пройдут и многообразно будет знание». Это разночтение существенно в том смысле, что интеллектуалам-революционерам XVII века, под влиянием идей которых был и Кант, проще было отождествить «Книгу природы», книгу Даниила, последние времена, географические открытия, Реформацию с вполне определенной точкой христианской истории — кануном второго пришествия Христа и обещанного Библией тысячелетнего царства праведников, подготовка к чему, в общем-то, и формировала программу «Великого восстановления». Бэкон так формулировал эту программу: «Ведь человечество направляет все свои силы на то, чтобы восстановить и вернуть себе то благословенное состояние, которого оно лишилось по своей вине. И против первого, главного проклятия — бесплодия земли («в поте лица своего будете добывать хлеб свой») оно вооружается всеми остальными науками. Против же второго проклятия — смешения языков — оно зовет на помощь грамматику» (Бэкон, 1971: 333).

Определяя место своей эпохи как конец тысячелетнего царства Антихриста, самоочевидным для интеллектуалов-протестантов, во всяком случае, олицетворением которого была Римская церковь, узурпировавшая право на посредничество между богом и человеком, интеллектуалы XVI–XVII веков уже самим фактом соучастия в великих исторических событиях кануна второго пришествия Христа выталкивались на критическую позицию переоценки всего того, что делалось на тысячелетнем периоде господства Римской церкви и уже поэтому было отмечено печатью Антихриста. Под огонь критики попадал, естественно, и сложившийся на этом периоде $T_u$, во-первых, потому, что входившие в состав тривия и квадривия «науки» опирались главным образом на античные авторитеты, на заведомых «язычников» и потому, во-вторых, что сам статус этих «наук» становился неодолимым препятствием развитию «естественной философии», как тогда именовали в рабочем порядке то, что стало позже естествознанием.

Курс подготовительного факультета, на котором осваивался $T_u$, обеспечивавший единую для интеллектуалов систему коммуникации, воспринимался в терминах пропедевтики к постижению истин Писания. Фома так объяснял отношения между «науками» и теологией: «Она не следует другим наукам как высшим по отношению к ней, но прибегает к ним, как к подчиненным ей служанкам... И само то обстоятельство, что она все-таки прибегает к ним проистекает не от ее недостаточности или неполноты, но лишь от недостаточности нашей способности понимания: последнюю легче вести от тех предметов, которые открыты естественному разуму, источнику прочих наук, к тем предметам, которые превыше разума и о которых трактует наша наука» (Антология мировой философии, 1969: 827).

Эта тезаурусная аргументация в пользу включения «наук» в последовательность стандартных ситуаций общения в курсах подготовки интеллектуалов до специализации как раз и вызывала ожесточенную критику. Бэкон, к примеру, считал, что,

действуя этим образом, схоласты в угоду Риму блокировали прогресс в естественной философии, самое теологию редуцировали «в форму учебника», инкорпорировали в религию «скучную и нудную моральную философию Аристотеля» и добились того, что «в течение всех этих столетий и до настоящего времени ни один индивид не сделал своей профессией естественную философию в том смысле, чтобы посвятить ей всю свою жизнь» (Klaaren, 1977: 102). Бэкон писал: «Бог не дал тебе надежного и заслуживающего доверия критерия, чтобы ты мог изучать с пользой писания других людей. Изучай небеса и землю, труды самого бога, и делай это, прославляя его в молитвах и возглашая гимны творцу» (Klaaren, 1977: 102).

В том же плане переориентации на «Книгу природы» писал и признанный герой интеллектуальной революции XVII века Бойль: «Так как бог бесконечно мудр, то природа — его великий субститут (являющийся ничем иным как активной мощью и активным законом, встроенным богом в мир и во все его составляющие) — движется к своим целям с совершеннейшей пруденцией. Имей мы остроту ума и любознательность для искусного постижения той мудрости, с которой природа предвидит далекие последствия, когда она отвергает угрожающие ей вещи и тайно лишает осуществимости то, что могло бы ей повредить, и будь мы достаточно ловкими в применении наших наблюдений к нашим делам и спорам, как в частной, так и в публичной жизни, мы могли бы вывести из них куда более состоятельное и невинное благоразумие, чем из книг Макиавелли и Тацита, обрели бы как честь, так и удовлетворение, управляя собой по тем же самым методам и великим максимам, по которым бог управляет миром» (Jacob, 1977: 100).

По ходу критики наследства, подозрительного на язычество и печать Антихриста, концепт «Книги природы», привычной для интеллектуалов реалии их повседневной деятельности, обрастал набором столь же привычных формально-когнитивных деталей. Тот же Бойль считал, что все божественное творение суть Кафедра, воздвигнутая божественным Автором для воспитания через естественное благочестие. Он убеждал, например, благочестивых читателей не спешить с выводами, учиться понимать язык творений: «Тот, кто способен заставить мир звучать, наделяя почти каждое творение и почти каждый случай языком, чтобы они развлекали его, кто может заставить малейшие случаи своей жизни, даже цветы своего сада, читать ему лекции по этике и теологии, тот вряд ли будет испытывать неодолимую тягу бежать от скуки в кабак» (Klaaren, 1977: 113–114). Этот момент заинтересованного чтения принимает у Бойля трансцендентальный смысл выхода в медитациях-размышлениях за пределы известного: «Нас забавляет неожиданность в вещах... Не следует в таких случаях, как и во многих других, предпринимать неуклюжие попытки поддержать разговор с нашими учителями, поскольку их инструкции неожиданны и, как если бы из засады, обстреливают наш разум из вещей, откуда мы выстрела не ждем, и таким образом мы получаем преимущество усваивать хорошие уроки без забот, выслушивая их в школе... Информация, которую мы получаем от множества творений и случаев, часто является весьма удаленной от того, что некто мог бы предположить как наиболее очевидное и естественное суждение о тех материях, которые предстают перед нами» (Klaaren, 1977: 114).

В целом же относительно «Книги природы» постулировались целостность и единство авторского замысла: «Чтение “Книги природы” любознательным умом мало похоже на чтение, скажем, басен Эзопа или какого-либо пестрого сборника, где каждый рассказ не зависит от другого. В “Книге природы”, как в хорошо составленном романе, части настолько пригнаны друг к другу и соотнесены друг с другом, а вещи, которые нам предстоит открыть, настолько темны или неполно познаны теми, кто приступает к ним, что ум никогда не будет чувствовать себя удовлетворенным, пока не дойдет до конца Книги» (Klaaren, 1977: 146). Вряд ли дело шло о простой метафоре. В достаточно серьезном для христианина документе, в завещании, Бойль писал в адрес членов Королевского общества: «Желаю им больших успехов в их похвальных попытках открыть истинную природу трудов Бога и молюсь, чтобы они и все другие искатели физических истин могли от всего сердца отдавать свои успехи славе великого Автора Природы и благу человечества» (Klaaren, 1977: 103–104). Если в свете этих попыток интеллектуалов-революционеров XVII века поставить «Книгу природы» в положение учебника, объединить трансцендентальное прочтение «Книги природы» с воспитанием в духе, скажем, «пансофии» Коменского с ее лозунгом «всем знать все обо всем» (Webster, 1976: 30), взглянуть на современное положение дел в нашей $T_y$-культуре, где все взрослеющее население движется во взрослое состояние по вымощенным учебниками, уроками, лекциями, занятиями целостным переходам, построенным по принципу: $T_1$ предшествующей стандартной ситуации общения становится $T_0$ последующей, — то можно с полной определенностью сказать, что мечты интеллектуалов-революционеров XVII века реализованы: человечество поставлено на обучение по «Книге природы».

В самом деле, включенность всех стандартных ситуаций в свои особые ассоциированные последовательности позволяет заметить принципиальное различие в тезаурусных статусах *A* и *B* в любой из таких последовательностей, входящей через начало $T_y$ в целостную систему развода взрослеющих индивидов по терминалам взрослой деятельности средствами формально-когнитивной техники. Выделяем ли мы для наблюдения стандартную ситуацию на школьном или студенческом, или на любом другом упорядоченном переходе в этой системе, мы всегда обнаруживаем полное тезаурусное подобие личных историй в группе *B*, хотя вовсе не обязательно все ее участники будут принадлежать к одной возрастной группе. В группе студентов, скажем, третьего курса философского факультета, присутствующей где-то в октябре на лекции по истории философии, могут обнаружиться люди, отслужившие в армии, и матери, воспитавшие детей, и те, кто далеко не сразу после школы решил специализироваться по философии. Но в тезаурусном отношении, как определители $T_0$ данной лекции, все члены группы подобны: у всех в прошлом средняя школа, два курса студенческой университетской подготовки, прочитанная часть лекций для третьего курса. Точно такой же результат будет фиксироваться в любой университетской или институтской аудитории, какую бы дверь ни открыть во время занятий.

Тезаурусный «зазор» между *A* и *B*, разность $T_1$ и $T_0$, в общем-то, невелик, не превышает для *B* академического часа, «45 минут ходу», чтобы уничтожить эту разность. Но если мы обратимся к анализу личных историй *A*, которые мы обнаруживаем в классах или аудиториях, открывая наугад двери то справа, то слева по коридору, то обнаружатся и сходства и различия: а) все *A* прошли в прошлом в составе своих групп *B* тот путь, по которому они сегодня ведут группы *B*; б) все *A* на постшкольном периоде прошли один из специализирующих путей академического сектора, курс студенческой подготовки; в) все *A* университетов прошли курс аспирантской подготовки и, защитив диссертации, получили формальное право на исполнение роли *A* в стандартных ситуациях студенческой и аспирантской подготовки; г) все *A* школьного и постшкольного

курсов подготовки либо закончили университет, либо прошли курс подготовки под руководством выпускников университета. Иными словами, только научно-академическое сообщество находится на кадровом самообеспечении воспитателями для всех представленных в университете дисциплинарных курсов подготовки, тогда как все остальные институты образование получают извне.

В университете — основной форме научно-академического сообщества — дисциплины представлены кафедрами, каждая из которых, оперативно включая результаты исследований на переднем крае дисциплины в процессы подготовки студентов и аспирантов, располагается на вершине иерархии воспитания воспитателей для всей системы развода взрослеющих индивидов в специализированные интервалы взрослой деятельности. С кафедры начинается обновляюще-онаучивающее движение элементов научного знания от переднего края дисциплинарных исследований, где эти элементы возникают, через учебники и курсы лекций университетов и педагогических институтов в стандартные учебники средней школы.

Освоенным обществом можно считать только то научное знание, которое представлено в учебниках общеобразовательной средней школы и определяет текущее значение $T_y$ как универсального $T_0$ всех мыслимых ситуаций общения между взрослыми *A* и *B* в общесоциальной системе синхронной коммуникации. Поскольку объем содержания учебников, признанных обществом обязательными для всех, жестко определен сроками обучения, которые с небольшими колебаниями из страны в страну составляют десять лет возрастного движения к $T_y$, к аттестату зрелости, к сборному пункту всех «новобранцев» для всех специализированных этапов постшкольной подготовки, а бюджет времени каждого индивида любой ежегодной волны, образующей *B*-группы в стандартных ситуациях общения между учителями (*A*) и учениками (*B*), не менее жестко определен суточным режимом жизни учеников как существ естественных, социальных и разумных, процесс обновления-онаучивания текстов $T_y$ всегда шел и идет в условиях насыщения, то есть, если в любой из действующих учебников общество полагает нужным включить раздел, объемом в десять стандартных ситуаций-уроков, то ровно такой же объем материала должен быть исключен из того же действующего учебника.

Движение новых элементов научного знания начинается с уровня «первичной литературы» или «эшелона статей» (Мирский, 1980: 129–143), где элемент представлен в форме отчета очевидца о репродуктивном по природе событии, регулярно наблюдаемом при указанных в отчете и экспериментально проверенных условиях. На одном только дисциплинарном этапе движения с уровня первичной литературы до включения в очередное издание дисциплинарного учебника элемент проходит три-четыре фильтра редукции и реинтерпретации, величина отсева в которых настолько велика, что, как пишет Э. М. Мирский, «одно единственное упоминание работы в учебнике “стоит” в глазах сообщества дисциплины десятков и сотен журнальных ссылок» (Мирский, 1980: 145).

Когда эти достаточно полноводные по началу потоки элементов нового знания — ни один дисциплинарный журнал, публикующий отчеты очевидцев с переднего края познания, не жалуется на избыточность листажа, хотя листаж этот увеличивается и весьма значительно (Петров, 1979) — достигают уровня школьных учебников, последнего фильтра перед входом в $T_y$ системы общесоциальной синхронной коммуникации, потоки, во-первых, остаются все же дисциплинарными и, скажем, признанная обществом необходимость внести изменения в учебник по биологии вовсе не предполагает необходимости вносить изменения в учебник по тригонометрии, а, во-вторых, каждый из потоков в отдельности порождает «карстовые» явления, вымывая из содержания текстов $T_y$ все то, что не подтверждается отчетами с переднего края или вытесняется как непродуктивное в методологическом отношении предшествующими фильтрами редукции и реинтерпретации элементов научного знания.



$T_y$, таким образом, «живет» и изменяется как целостность, оставаясь в этих изменениях устойчивой по объему и структуре реалией, воспроизводимой ежегодными волнами учеников, образующих *B*-группы в стандартных ситуациях общения на уроках. Поскольку характер этих изменений производен как от событий на переднем крае научного познания, так и от перипетий движения элементов знания в независимых дисциплинарных потоках через фильтры редукции и реинтерпретации, пытаться предсказать, каким $T_y$ будет через 20 или 50, 100 лет, что в нем останется, а что исчезнет, уступив место новому, дело столь же бесперспективное, как и предсказывать события на переднем крае научного познания мира.

С другой стороны, связь когнитивного движения через ассоциированные стандартные ситуации между *A* и *B* с естественным взрослением по программам биокода позволяет без труда предсказать, что и в близком, и в отдаленном будущем формально-когнитивная техника, коль скоро она учитывает физические и ментальные возможности индивидов, вряд ли претерпит существенные изменения. В этом смысле тезаурусный «зазор» между *A* и *B*, наблюдаемый в стандартных ситуациях общения, разность $T_1-T_0$, приобретает свойства естественного векторного определителя когнитивных структур, меры «проходимости», «человекоразмерности» социально-когнитивных реалий.

Вводя тезаурусные коррективы в классическую модель акта речи Соссюра, мы основное внимание концентрировали на когнитивной динамике поступательности, трансцензуса, на шаговом сдвиге начального тождества тезаурусов *A* и *B* в новое $T_1$ значение, то есть разность $T_1-T_0$ интересовала нас как разность отличная от 0 и позитивная, обеспечивающая поступательность шагового движения в $T_y$-системе развода взрослеющих индивидов по когнитивному основанию к предзаданным значениям ассоциированных последовательностей — к аттестату зрелости, дисциплинарному университетскому диплому, диплому учителя, терапевта, инженера и т. п. Теперь же, обнаружив, что все *A* действующих последовательностей-переходов причастны в своих личных историях к одной из дисциплинарных иерархий воспитания воспитателей и к соответствующему потоку элементов научного знания между передним краем познания и учебником средней школы, выступают в стандартных ситуациях общения (перед *B*, в частности, и в роли вестников о событиях на переднем крае науки), мы имеем право утверждать, что в отличие от диссоциированных стандартных ситуаций (доклад, статья, монография), предполагающих тождество личных историй *A* и *B*, ассоциированные стандартные ситуации (урок, лекция, занятие), предполагающие причастность *A* к процессу обновления-онаучивания общества через изменение текстов $T_y$ в условиях насыщения и значительный разрыв по времени между личными историями *A* и *B*, есть организованный когнитивной техникой *контакт поколений*, то есть все *A* принадлежат относительно *B* к предшествующему поколению, а все *B* относительно *A* — к живущему.

Иными словами, тезаурусный «зазор» между *A* и *B* может оказаться тем «игольным ушком», через которое взрослые живущего поколения протаскивают унаследованный ими мир культуры, вводя в наследство взрослеющую смену, а возможно,

если учесть режим насыщения и жесткость сроков движения по этапам во взрослое состояние, то и «калибром» достаточно жесткой геометрии, безжалостно срезающим культурные «излишества». Мы, например, вовсе не убеждены в том, что лет через 50–100 выпускникам средней школы и взрослому населению в целом будут что-нибудь говорить имена Лейбница, Вольтера, Ломоносова, Гете, Канта, Байрона, Пушкина, Лермонтова, — все это может пасть жертвой карстовых эффектов обновления и онаучивания текстов $T_y$. Но так или иначе, подозрение на причастность разности $T_1$–$T$ не только к построению последовательностей по принципу: $T_1$ предшествующей ситуации общения между $A$ и $B$ становится $T_0$ последующей, — но и к структуре проходимого для человека стыка поколений, вынуждает обращать внимание как на отличный от 0 и положительный смысл разности $T_1$–$T_0$, что обеспечивает поступательность когнитивного движения, не входя в детали его шаговой размерности, так и на некоторое критическое значение этой разности, за пределами которого стандартная ситуация общения между $A$ и $B$ становится для $B$ непроходимой. Без привлечения идеи критического значения разности $T_1$–$T_0$ становится непонятным, почему когнитивное движение должно совершаться шагово, дискретно или почему, скажем, все языки членораздельны и на уровне предложений связного текста не терпят повторов, как нет их для $B$ и в последовательностях, по которым они движутся.

В самом деле, если нет некоторого «кванта» проходимости, с параметрами которого приходится считаться, то совершенно непонятно, почему, скажем, общество, санкционируя право учителя вести учеников к $T_y$ именно потому, что учитель знает, что такое $T_y$ и куда ему надлежит вести учеников, не требует от учителей, как оно требует во многих других случаях, большей расторопности, оперативности, перевыполнения планов по ускоренному или даже единым махом, в едином порыве прохождению тезаурусной разницы $T_y$–$T_n$, а позволяет им растягивать эту «скуку науки» на десять лет. Если есть некий ограничитель, как бы его ни назвать, — критическое значение, потолок, квант достижимого в одном импульсе, — то ситуация в общем-то понятна. На свете хватает теоретически простых, а практически невозможных для человека вещей: любой тренер фигурного катания с удовольствием включил бы, скажем, сегодня прыжки в десять оборотов в программы подготовки фигуристов к предстоящей олимпиаде, и если он не делает этого, то не потому, что наука не позволяет — она-то как раз позволяет, любой теоретик-механик решит для тренера эту элементарную задачу на вращение материальной точки, а потому, что спортсмены — не материальные точки и не все объективные истины науки истинны субъективно. Думается, что нечто в этом роде, превращающее стандартные акты общения между $A$ и $B$ с разностями типа $T_y - T_n$ или $T_д$–$T_y$ в непроходимые «прыжки в десять оборотов» и вынуждающее разбивать школьные, студенческие и иные переходы на ассоциированные последовательности проходимых ситуаций, имеет силу и для динамики движения по когнитивному основанию, превращая это движение в шаговый дискретный процесс кумулятивного инкрементного роста тезауруса $B$ в предзаданном $A$ направлении.

Но дело не только в этом. Допущение о присутствии в упорядоченной динамике когнитивного движения критического значения разности $T_1$–$T_0$ дает ориентир для поисков ответов на основные поставленные Кантом вопросы. Стандартная ситуация общения между $A$ и $B$, если представленный разностью $T_1$–$T_0$ сдвиг значения тезауруса $B$ понят как инкрементное приращение личной истории $B$, накопленной



в аналогичных предшествующих ситуациях, а выбранная для анализа ситуация принадлежит к школьному этапу, который обязаны пройти все, придает наблюдаемому в такой ситуации событию всеобщий характер, разделяя всю $T_y$-систему когнитивного движения индивидов к терминалам специализированной деятельности на две области: до $T_y$; после $T_y$. В области после $T_y$ постановка вопроса во всеобщей форме бессмысленна, поскольку от $T_y$ и за $T_y$ идут специализирующие этапы, каждый из которых содержит $T_y$ в качестве условия осуществимости когнитивного движения и, соответственно, любые поставленные в этой области вопросы войдут в связь с независимыми друг от друга иерархиями воспитания воспитателей, будут вопросами о частном фрагменте научного знания.

В $T_u$-культуре этого четко обозначенного разделения областей не было, поскольку упорядоченное когнитивное движение затрагивало сравнительно небольшую группу терминалов взрослой деятельности — интеллектуальные профессии. Но, надо полагать, предписанные биокодом этапы естественного взросления, движения параметров физических и ментальных характеристик по возрасту индивидов вряд ли существенно отличались от тех, которыми сегодня определяются характеристические возрастные точки общесоциальной системы когнитивного движения — 1-й класс, аттестат зрелости, диплом, — которыми задаются сроки обучения, число стандартных ситуаций общения в школьной и постшкольных ассоциированных последовательностях, среднее значение сдвига $T_1$–$T_0$, проходимое для $B$ за время урока, лекции, занятия.

Это обстоятельство — практическая неизменность детерминированного через биокод естественного фона, на котором возникала и претерпевает изменения $T_y$-система когнитивного всеобщего движения взрослеющих индивидов через унифицирующую (до $T_y$) и специализирующую (после $T_y$) ее части, — позволяет предположить, что и на периоде $T_u$, и на периоде $T_y$, действует один и тот же набор стабилизирующих факторов, задающих объем того, что может быть освоено человеком и на периодах возрастного движения, и в ограниченных по времени актах общения между $A$ и $B$, а наблюдаемые существенные различия между $T_u$- и $T_y$-культурами связаны в основном со степенью экспликации действия этих факторов. Доминирующее положение формально-когнитивной техники организации возрастных периодов в $T_y$-культуре просто, похоже, выводит на уровень наблюдения и научного изучения те механизмы детерминации, которые связывают естественное возрастное движение индивидов с их когнитивным движением во взрослое состояние наследников предшествующего развития культуры и субъектов изменения переданного им по когнитивному основанию наследства.

В этом смысле существующая вот уже около сотни лет $T_y$-культура может рассматриваться как «долготный», длительный по времени эксперимент, частично подтверждающий, частично опровергающий те «законченные ряды условий», которые возникали на периоде $T_u$. О «долготности» приходится говорить в том смысле, что процесс верификации идет в основном «карстовым» способом вымывания из текстов $T_y$ тех идей, постулатов, концепций, которые признавались на периоде $T_u$ как само собой разумеющееся, но не подтверждаются практикой априорного схематизма на переднем крае исследований, выходят из употребления и перестают указываться в отчетах о событиях в числе условий осуществимости наблюдаемых событий.

Система априоризма Канта, организованная в последовательность: трансцендентальная эстетика — трансцендентальная логика — трансцендентальная диалектика,

не претерпела, на наш взгляд, существенных потерь и остается в рабочем арсенале практики научного познания именно потому, что она переориентировала поиск трансцендентальных начал на личные истории исследователей, которые обретаются в возрастном движении индивидов по когнитивному основанию.

Канта, как и его современников, ближайших последователей и критиков, относительно мало заботила связь когнитивного движения с естественным взрослением, которое устанавливает когнитивному движению вехи и сроки их прохождения на конечном периоде человеческой жизни, поэтому «коперниковская составляющая» кантовского априоризма первоначально эксплицировалась как перевод «после вещей», логики Аристотеля из статики, в какой она представлена у Канта, в динамику. В нашей $T_y$-схеме это означало признать наличие сдвига $T_1 – T_0$ в стандартной ситуации общения между *A* и *B*, засечь некую наблюдаемую ассоциированную ситуацию и двигаться к началу последовательности таких ситуаций, в личную историю *B*, используя организующий последовательность принцип: $T_1$ предшествующей ситуации становится $T_0$ последующей. Основной идеей классической диалектики как когнитивного поступательного шагового движения во времени, как самосознания, опирающегося в трансцензусе на накопленную историю, была, по нашему мнению, ассоциированная стандартная ситуация общения между *A* и *B*, понятая как член последовательности, «труп тенденции», конечный результат личной истории *B* — начальная сумма условий осуществимости предстоящего шага, как $T_0$. Присутствие *A* в этой ситуации «Я — не Я, отрицание отрицания», в этой ключевой структуре поступательного самосознания предполагалось, но явно не подчеркивалось: активной стороной выступал *B*, для которого каждое трансцендентальное перешагивание разности $T_1 – T_0$ открывало новые перспективы познания самого себя. На наш взгляд, именно такой подход позволял с наименьшими потерями и потрясениями включить априоризм Канта в традиционную, основанную на акте божественного творения схему синтеза: до вещей — в вещах — после вещей, обойти основную возникающую здесь трудность — связь когнитивного движения с естественным взрослением, определение исходного для последовательности ассоциированных ситуаций значения $T_0$ первой стандартной ситуации между *A* и *B*.

Гегель, например, пройдя в «Феноменологии духа» историю движения *B*-духа к Гегелю, в «Науке логики», пытаясь пройти в попятном движении от Гегеля к началу последовательности, по сути дела, восстанавливает тот «истиноцентрический» взгляд на познание, который Кант пытался перевернуть: «Итак, в настоящем произведении понятие чистой науки и ее дедукции берутся как предпосылка постольку, поскольку феноменология духа есть не что иное, как дедукция его. Абсолютное знание есть *истина* всех способов сознания, потому что, как показало <описанное в «Феноменологии духа»> движение сознания, лишь в абсолютном знании полностью преодолевается разрыв между *предметом и достоверностью самого себя*, и истина стала равной этой достоверности, так же как и эта достоверность стала равной истине... В качестве *науки* истина есть чистое развивающееся самосознание и имеет образ самости, <что выражается в том>, что *в себе и для себя сущее есть осознанное понятие*, а *понятие как таковое есть в себе и для себя сущее*. Это объективное мышление и есть содержание чистой науки. Она поэтому в такой же мере не формальна, в такой мере не лишена материи для действительного и истинного познания, что скорее ее содержание и есть абсолютно истинное или (если еще угодно пользоваться словом «материя») подлинная материя, но такая материя, для которой форма не есть нечто внешнее, так как эта материя есть скорее чистая мысль и, следовательно, есть сама абсолютная форма. Логику, стало быть, следует понимать как систему чистого разума, как царство чистой мысли. *Это царство есть истина, какова она без покровов, в себе и для себя самой*. Можно поэтому выразиться так: это содержание есть *изображение бога, каков он в своей личной сущности до сотворения природы и какого бы то ни было конечного духа»* (Гегель, 1970: 102–103).



Этот выход в традиционную для $T_u$ позицию «до вещей», за акт творения как начала всех начал, имел и то преимущество, что движение по *личной истории B* к прошлому, к началу последовательности стандартных ситуаций общения между *A* и *B* обеспечивало автоматическое выполнение не только исходных постулатов трансцендентальной эстетики Канта о пространстве как внешней и времени как интериоризированной чистых формах чувственного созерцания — все, в общем-то, так и происходит у индивида или группы в позиции *B*, — но и центрального, на наш взгляд, постулата трансцендентальной логики об единстве апперцепции, трансцендентальном единстве самосознания: «Синтетическое единство многообразного <содержания> созерцаний как данное a priori есть основание тождества самой апперцепции, которая a priori предшествует всему *моему* определенному мышлению. Однако не предмет заключает в себе связь, которую можно заимствовать из него путем восприятия, только благодаря чему она может быть усмотрена рассудком, а сама связь есть функция рассудка, и сам рассудок есть не что иное, как способность a priori связывать и подводить многообразное <содержание> данных представлений под единство апперцепции. Этот принцип есть высшее основоположение во всем человеческом знании» (Кант, 1964: 193).

Похоже, что именно эта способность рассудка априорно подводить под единство апперцепции содержательное многообразие и пестроту представлений как раз и сыграла роль поворотного круга для «законченного ряда условий» $T_u$-культуры. Кант ставил акцент на целостности субъекта, Я: «Только в силу того, что я могу постичь многообразное <содержание> представлений в одном сознании, я называю их *моими* представлениями; в противном случае, я имел бы столь же пестрое разнообразное Я (Selbst), сколько у меня есть сознаваемых мной представлений» (Кант, 1964: 193).

При $T_y$-системе развода взрослеющих индивидов в терминалы специализированной взрослой деятельности, как, видимо, и при другой системе того же назначения, реализованной в других культурных типах, мы имеем дело с целостными Я. В личной истории любого индивида, будь он взрослеющим или взрослым, мы не обнаруживаем ни условий, ни поводов, которые требовали бы расщепления личности, множественного Я. Такое требование было бы невыполнимым, любой набор ролей обязан укладываться в бюджет времени, в рамках физических и ментальных возможностей индивида. И в нашей $T_y$-культуре, от какого бы терминала взрослой деятельности мы ни совершали попятное движение, повторить подвиг Гегеля в «Науке логики», выявить начало когнитивного движения по истории индивида, который в поступательном когнитивном движении оказался там, где мы его обнаружили, мы вынуждены будем всякий раз убеждаться в том, что перед нами отнюдь не «изображение бога, каков он в своей вечной сущности до сотворения природы, и какого бы то ни было конечного духа», а сам этот «конечный дух» в момент его сотворения, младенец, который заявляет криком о своем появлении на свет и готовности лет

через шесть-семь включиться на правах первоклассника в действующую систему развода младенцев через $T_y$ в терминалы взрослой деятельности.

В $T_y$-культуре субституция бога младенцем — более или менее очевидный факт, хотя полная ясность начинается с $T_n$, с тезауруса первоклассника, с начала действия упорядочения последовательностей стандартных ситуаций, ни одна из которых не содержит ни одной непроходимой для $B$ ситуации, тогда как предшествующий $T_n$ период «от 2 до 5» не обнаруживает четкой организации. При всем том, выявленность механизмов когнитивного движения в целом и особенно механизмов воздействия дисциплинарных потоков обновления-онаучивания, иерархий воспитания воспитателей на тексты $T_y$ — феномен сравнительно недавнего происхождения, так что, скажем, наблюдаемые сегодня карстовые эффекты — промоины и лакуны, проходящие через всю толщу научной коммуникации от ежегодных собраний академий наук до учительских на переменах в школе, очевидно, не могли возникнуть до появления дисциплинарной дифференциации научного познания и перехода системы подготовки исследовательских кадров с текстов $T_u$ на общеобязательные тексты $T_y$, а все это происходило далеко не сразу и требовало, как и всякий процесс преемственных изменений, времени.

Ключевыми событиями этого переходного периода отказа от $T_u$ «добровольцев» и перехода на $T_y$ «новобранцев» мы считаем реформы Гумбольдта 1808–1810 годах, внедрившего в Берлинском университете «профессорскую» модель связи исследования и преподавания в одном ролевом выборе члена научно-академического сообщества, а также и в большей степени принципы униформизма и актуализма, сознательно использованные сначала Лайелем для построения геологической «вечности», затем Дарвином для объяснения сохранения разнообразия видов в условиях их вымирания.

Лайель и Дарвин, по сути дела, реализовали схему кантовского априоризма, начав отсчет глубины вечности, истории наблюдаемых явлений не от акта творения, а от «здесь и сейчас» наблюдения, исследования, что стало теперь нормой построения любых дисциплинарных предметов, их историй. Позиции «до вещей», где традиционно находился бог «в своей вечной сущности до сотворения природы и какого бы то ни было конечного духа», исчезла, зато вещи, как и конечные духи, как и Библия и «Книга природы», получили отметку возраста, то есть в актуализме через концепт эволюции вошли в связь естественное взросление и когнитивная поступательность, возникла примерно та же ситуация, которую мы наблюдаем сегодня в $T_y$-культуре: по возрасту индивида можно достаточно точно судить о его положении в системе развода младенцев в терминалы взрослой деятельности и, наоборот, по положению в этой системе — о его возрасте.

Непосредственным поводом для переноса точки отсчета из «до вещей» в «здесь и сейчас» текущих исследований была проблема вымерших видов, которая явно не вписывалась ни в синтез Фомы, ни в представления интеллектуалов, включая Канта и Гегеля, о том, как именно должны выявлять себя во времени реалии божественного плана, реализованного «в вещах» в акте творения, ни даже в библейскую историю, где Ною на время потопа указано было сохранить все животные виды. Джефферсон, например, писал о смысле проблемы исчезновения видов: «Ведь если даже потеряно одно только звено в естественной цепи, то могли бы потеряться и другие, и вся система должна была бы постепенно исчезнуть» (Green, 1971: 10). Но «здесь и сейчас» земляных работ в Париже и его окрестностях, затеянных в начале XIX века



ради придания Парижу лоску, достойного столицы Франции, выдали Музею естественной истории Франции такую груду костей, что для Кювье, отца сравнительной анатомии, ничего другого не оставалось, как признать смертность животных видов и, сохраняя христианско-интеллектуальную парадигму естественной истории Линнея, предложенную в XVII веке Линнеем и Реем, по которой «живые существа изначально сотворены богом и им же сохранены по сей день в том же состоянии и в тех же условиях, в каких они были созданы впервые» (Green, 1971: 10), разрушить основу единства апперцепции, ввести множественность «до вещей». Анализируя сложившуюся ситуацию в «здесь и сейчас» раскопок в парижском бассейне, Дж. Грин пишет: «К чести гения Кювье следует отнести то, что, создав своими же исследованиями кризис, он сам же и предложил решение. Распространяя метод и принципы сравнительной анатомии на изучение органических ископаемых, он демонстрировал различия между живущими и ископаемыми видами, вводил последние в область систематики естественной истории. В то же время, принимая геологический катастрофизм Жана Делюка, он сохранял основные черты статической парадигмы Линнея. Виды могли исчезать в результате драматических катастроф неизвестного происхождения, но в интервалах между катастрофами господствовали стабильность и мудрое устроение, обеспечивая тем самым устойчивую основу для ретроспективной таксономии» (Green, 1971: 10–11).

Но такое решение входило в явное противоречие с библейской историей и с подтверждающими ее данными $T_u$ науки. У. Бекланд, например, теолог, сначала читавший естественную историю в Оксфорде, а затем настоятель Вестминстера, опубликовал в 1823 году книгу со множеством свидетельств в пользу того, что потоп действительно был и что Ной выполнил возложенную на него миссию сохранить разнообразия животных видов. Д. Найт так описывает частную деталь его эксперимента: «По ходу своих изысканий он скармливал кости живым гиенам в подтверждение того, что они раскусывают кости тем же способом, каким были расколоты кости, найденные в одной из пещер Йоркшира, и что испражнения живых гиен аналогичны по составу найденным в пещере. Сама противоречивость этой программы исследований указывает на долгий период скрытого существования твердой веры в униформизм природы. Людей типа Бэкланда или Кювье приводило в смущение другое, а именно то, что Библия позволяет найти шкалу времени для земной истории, которая по этой шкале начиналась где-то в 4004 году до н. э.» (Knight, 1976: 67).

Лайель пытался закрыть проблему, вводя принципы униформизма и актуализма. Требуя в принципе актуализма ограничивать объяснения наблюдаемых изменений наблюдаемыми же причинами, он, очевидно, оставался в рамках трансцендентальной логики Канта, но, в отличие от характерного для немецкой классики перевода категорий рассудка в динамику диалектического когнитивного движения и, соответственно, превращения категориально-сказуемостного формализма Аристотеля — «сколькими способами сказывается, столькими способами и означает себя бытие» (Метафизика, 1017 а) — в познанные объективные определения бытия, что обеспечивало выход через отношения истинности в «до вещей» Платона и платоников, Лайель превращал униформизм плана лишь в вектор, направленный от настоящего в прошлое ради предоставления наблюдаемым в «здесь и сейчас» агентам изменения — участвующим в объяснениях наблюдаемым причинам — времени, достаточного для их выявления. Лайель писал: «Если униформизм плана принят на правах посылки, то за событиями, которые произошли в самые отдаленные периоды

в одушевленном или неодушевленном мире, должно быть признано право проливать свет на любое другое событие и восполнять неполноту нашей информации относительно некоторых темных частей современного творения» (Knight, 1976: 9).

Лайель, как и Дарвин, не отвергают акта творения, «начала», коль скоро униформизм плана, позволяющий событиям прошлого «проливать свет» на последующие и восполнять недостаток информации о «наиболее темных частях современного творения» должен заведомо присутствовать в предмете познания, априорно предполагаться до «здесь и сейчас» наблюдения и эксперимента как сумма репродуктивных характеристик, которая открывает возможности интериоризации, подведения пестроты и многообразия восприятий под единство апперцепции, перевода их в упорядоченной форме в личную историю наблюдателя, осмысленного общения с коллегами, если они и наблюдатель обладают общностью личных историй, а наблюдаемое и воспроизводимое в экспериментах дает наблюдателю повод построить разность $T_1$–$T_0$, занять роль $A$ и сообщить коллегам нечто им неизвестное с помощью универсальных средств когнитивной техники.

Но, постулируя присутствие «начала» в прошлом как гаранта трансцендентальной познавательности любого соразмерного физическим и ментальным возможностям человека фрагмента данности, модель Лайеля–Дарвина не фиксирует значений разрыва между «началом» и «здесь и сейчас» исследования, что создает на месте акта божественного творения, начала всех начал $T_u$-культуры, оправдывающего существование «истинно-центричной» точки зрения, расплывчатое, уходящее от настоящего в прошлое пятно начал, допускающих лишь относительное определение по глубине «дисциплинарных вечностей», когда, скажем, геологическая вечность «глубже» биологической, биологическая — социальной и т. д. Словом, в общем случае возникает примерно та же картина, какую рисует Соссюр в попытках научно построить предмет науки о языке: «Во всякую эпоху, как бы далеко в прошлое мы ни углублялись, язык всегда выступает как наследие предшествующей эпохи. Нетрудно себе представить возможность в прошлом акта, в силу которого в определенный момент названия были присвоены вещам, то есть в силу которого было заключено соглашение о распределении определенных понятий по определенным акустическим образам, хотя реально такой акт никогда и нигде не был зафиксирован... Фактически всякое общество знает, и всегда знало язык как продукт, который унаследован от предшествующих поколений и который должен быть принят таким, как он есть. Вот почему вопрос о происхождении языка не так важен, как обычно думают. Такой вопрос не к чему даже ставить; единственный реальный объект лингвистики — это нормальная и регулярная жизнь уже сложившегося языка» (Соссюр, 1977: 104–105). Иными словами, акт творения не исключается, но и не предполагается. Просто источник определенности наблюдаемого состояния нужно искать в прошлом, идти в попятном движении через предшествующие состояния без особой надежды выйти к исходному состоянию — акту творения определенности.

В нашей $T_y$-культуре все такие попятные движения, если идти по личным историям индивидов, сходятся на этапе «от 2 до 5» как на начале всех начал. Но это уже другая тема. В заключение можно сказать, что живучесть идей кантовского априоризма связана именно с переориентацией анализа универсалий научного знания на человеческое основание упорядоченного когнитивного знания индивидов, за которым стоит на правах инерционного фона естественное возрастное движение индивидов. $T_y$-система развода взрослеющих индивидов в терминалы



специализированной взрослой деятельности, как и процессы онаучивания общества через обновление текстов $T_y$, позволяют более четко сформулировать поставленные Кантом проблемы. Но сегодня рано еще говорить о конкретных результатах, предпочтительнее говорить о программе исследований.

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# Sociology of Science and Technology
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The journal aims to provide the most complete and reliable source of information on recent developments in sociology of science and technology.

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