STATISTICAL APPENDIX (Appendix1)

Review of the availability of empirical data according to the proposed indicators[1]

Background statistics

a. Size of the national innovation system

Table A.1. Main S&T indicators in 1992

FIN	1992
Population (thousands)	5 042
Labour force (thousands)	2 527
Gross domestic product, GDP (million current PPP USD)	75 764
Gross domestic expenditure on R&D, GERD (million current PPP USD)	1 651
GERD / GDP (%)	2,2
Total R&D personnel	29 344
Total R&D personnel per thousand labour force	11,6
Total researchers	13 868
Total researchers per thousand labour force	5,5
OECD, Main Science & Technology Indicators 1995/1	

b. The financing of the R&D activities

Table A.2. Gross domestic expenditures on R&D by sector .

	1991
Percentage of GERD financed by industry	56,3
Percentage of GERD financed by government	40,9
OECD, Main Science & Technology Indicators 1995/1	

[1] For a complete listing of the proposed indicators, see Appendix 2.

c. The execution of the R&D activities

Table A.3. GERD by performing sectors in 1992.

	1992
% of GERD performed by the business enterprise sector	56,8
% of GERD performed by the higher education sector	22,0
% of GERD performed by the government sector	20,6
Business enterprise expenditure on R&D, BERD (million current PPP USD)	936,8
BERD (million national currency)*)	5 896
OECD, Main Science & Technology Indicators 1995/1 **) OECD, DSTI(STAN/ANBERD), 1994*	

d. Other background data

See data presented in Chapters 2 and 3 of the main report.

1. Indicators of the stocks and flows of knowledge

I.1 Learning through training

I.1a - formal training provided by employers (intensity, distribution by type of firm/ technology)

- A Statistics Finland publication "Participation in In-service training in 1993" contains in-service training statistics by type of employment, employment sector and by firm size.

Table A.4. No. of employees participating in formal training provided by employers

Professional group	1991			1993		
	No. of Salaried employees x 1000	No. having attended training by employers x 1000(%)	No. of training days per participant a year	No. of Salaried employees x 1000	No. having attended training by employers x 1000(%)	No. of training days per participant a year

Industry, building and mining work total	419	108 (25.8%)	6.7	342	80 (23.4%)	4.4
Source : Statistics Finland, Participation in In-service training in 1993, Appendix Table 9.						

Table A.5. Participation in continuting education and training

% of employed population 25 to 64 yrs of age having participated in job- or career-related continuing education and training, by educational level (in 1990)	Men & Women	Men	Women
Lower secondary education	28	23	33
Upper secondary education	47	42	52
Non-university tertiary education	73	69	79
University education	74	74	74
Total	46	43	50

OECD Education Statistics 1985 - 1992

I.1b - science and engineering personnel (total national stock and breakdown by sector and type of employment)

- A Statistics Finland publication "Science & Technology 1995:1" contains data on R&D personnel by educational background and by sectors.

Table A.6. R&D personnel by sectors

	1991	1993
Total business enterprise R&D personnel (%)	15028 (51,2%)	15180 (50,1%)
Total R&D personnel at higher education institutes (%)	7662 (26,1%)	8422 (28,7%)
Total R&D personnel at government sector (%)	6654 (22,7%)	6655 (22%)
Total	29344	30257

OECD, Main Science & Technology Indicators 1995/1

Table A.7. Researchers by sector

	1991	1993
Total business enterprise researchers (%)	5170 (37,3%)	5453 (36,3%)
Total researchers at higher education institutes (%)	5455 (39,3%)	6097 (40,6%)
Total researchers at government sector (%)	3243 (23,4%)	3477 (23,4%)
Total	13868	15027

OECD, Main Science & Technology Indicators 1995/1

Table A.8. R&D personnnel by sector

R&D personnel in Finland in 1993	Total	of which women

Total	42 099	13 559
Business enterprise sector	19 678	4 395
Government sector	9 077	3 965
HEI's	13 344	5 199
Statistics Finland : Science & Technology 1994:3 Appendix tables		

Table A.9. R&D personnnel in business enterprises

R&D personnel in business enterprise sector in 1993	Total	of which women
Total business enterprise sector	19 678	4 395
- Agriculture, hunting and fishing	27	10
- Mining and quarrying	68	18
- Energy and water supply	372	69
- Construction	195	28
- Trade	165	31
- Transport and communications	483	56
- Financial intermediation	-	-
- Business activities	1 915	334
- Education and research	418	210
- Other government services	113	15
- Manufacturing sector total	15 922	3 624
Manufacturing sector by industry:		
- Food, beverages, tobacco	999	532
- Textiles	128	79
- Wearing apparel, leather, footwear	35	12
- Wood and wood products	149	14
- Pulp and paper, paper products	1 009	383
- Printing and publishing	206	49
- Furniture	75	7
- Chemicals	2 563	1 278
- Petroleum, coal, rubber, plastic products	291	46
- Glass, clay, stone products	407	103
- Metals	688	100
- Metal products	449	7
- Machinery, equipment	2 070	147
- Electrical products, instruments	6 083	825
- Transport equipment	638	33
- Other manufacturing	132	10
Tilastokeskus: Tutkimus- ja kehittämistoiminta 1993, Tiede & teknologia 1994:3 liitetaulukot		

Table A.10. R&D personnel in the manufacturing sector

Industry	R&D personnel		Personnel w/ highest levels of education			
	Total	of which women	Ph.D.s	of which women	Licentiate Degrees	of which women

Manufacturing sector totals ..... (Data by Industry available)	15 922	3 624	347	58	367	56

Source: STATISTICS FINLAND, Science & technology 1995:1, Table 6.

I.2 Learning by doing

I.2a - cumulative R&D expenditures (distribution by type of firm/technology)

Table A.11.Total cost of innovation activities by industry in 1991 (million FIM)

Cost	Manu-fac-turing sector	Food, beve-rages tobacco	Textiles leather foot-wear	Wood, wood pro-ducts	Pulp, paper, paper pro-ducts	Pub-lishing, printing	Furni-ture	Chemi-cals	Other chemical products, petroleum coal
Total cost of innovation activities	11501	1188	301	335	2145	369	138	827	641
Total cost of R&D in unit	5553	329	137	74	394	90	55	570	485
- Intramural R&D	4730	277	117	54	313	72	47	485	412
- Extramural R&D	823	52	20	20	81	18	8	85	73
Total cost of other innovation acitivities	5948	859	163	261	1751	278	83	257	156
- Acquisition of technology	206	26	6	1	12	3	17	9	13
- Acquisition of new production capacity	4617	731	79	204	1575	212	49	214	68
- Application of innovations (1): training & education costs	205	17	12	7	43	17	6	4	8
- Application of innovations (2): tooling software, trial production, organiz. devt	532	34	24	30	97	36	6	22	14
- Marketing of innovations	389	51	43	18	22	11	5	7	53
STATISTICS FINLAND, Innovation survey of 1992									

(Table continued:)

Cost	Rubber plastic pro-ducts	Glass, clay, stone products	Metals	Metal products	Machi-nery, equip-ment	Electrical products, instru-ments	Trans-port equip-ment	Other manufac-turing products
Total cost of innovation activities	199	462	643	517	1023	2162	421	131
Total cost of R&D in unit	85	287	98	303	673	1748	171	53
- Intramural R&D	74	243	80	260	577	1549	137	32
- Extramural R&D	10	43	19	43	96	198	34	21
Total cost of other innovation acitivities	114	175	545	214	350	415	249	78
- Acquisition of technology	10	8	4	13	37	31	5	9
- Acquisition of new production capacity	72	137	507	151	198	162	201	56
- Application of innovations (1): training & education costs	5	7	7	14	27	14	13	2
- Application of innovations (2): tooling software, trial production, organiz. devt	19	14	18	25	55	121	13	4
- Marketing of innovations	10	9	9	10	32	87	17	7
STATISTICS FINLAND, Innovation survey of 1992								

From the above table, data also for the following proposed indicators:
(1) I.2 Learning by doing: I.2a - cumulative R&D expenditures
(2) II.2.3 Importance of property right system in knowledge transfer and distribution
(3) I.1 Learning through training: I.1a - formal training provided by employers

Table A .12. BERD in large Finnish concerns, large and medium-sized firms in Finland in 1992

Industry	All surveyed firms		Large concerns		Other large and medium-sized firms	
	Total R&D expenditures mill.FIM	% of R&D conducted overseas	Total R&D expenditures mill.FIM	% of R&D conducted overseas	Total R&D expenditures mill.FIM	% of R&D conducted overseas
All firms in the survey.....	5 413	24	4 051	29	1 362	10
Source: STATISTICS FINLAND, Åkerblom, Internationalization of the Finnish firms' R&D, Table 3						

Table A.13. Business enterprise expenditures on R&D in 1993

Industry	R&D expenditures of the work performed by the unit	Other R&D expenditures (1)	
	total million FIM (1)	total million FIM	of which contract research performed by others***)** (% of contract research conducted oversears)
Manufacturing sector totals ..... (BERD total)	5 269.4 (6 234)	1 015.9	936.4 (43.5%)
Source: STATISTICS FINLAND, Science & technology 1995:1, Table 9.			

From the above table, data also for the following proposed indicators:
(1) I.2 Learning by doing: I.2a - cumulative R&D expenditures
*) See also next Table.

Table A.14. Contract research performed by others, million FIM in 1993

Industry	Contract research total	Contract research performed in Finland					Contract research performed abroad				
		within the firm	in other firms (1)	in research organi-zations (2)	in univer sities (3)	in other organi-zations	within the firm	in other firms (1)	in research organi-zations (2)	in univer sities (3)	in other organi-zations
Manufacturing sector totals ..... Data available by industry	936.4	281.8	101.0	84.4	39.6	22.7	304.5	54.6	31.2	10.7	4.5
Source: STATISTICS FINLAND, Science & technology 1995:1, Table 10.											

From the above table, data also for the following proposed indicators:
(1) II.2.2 Research within and between enterprises
(2) II.1.2 Bridging institutions
(3) II.1.5 Methods of learning in university-industry relations: II.1.5f - contract R&D

Table A.15. Funding for business enterprise R&D by funding source in 1993, million FIM

Funding source	million FIM	% of funding total
Firms'own funding total	5 198	83
Government sector funding total	370	6
- *TEKES*)*	310	
- *Other funding from Ministry of Trade & Industry*		
- *Funding from other Ministries*	52	
	8	
Other outside funding from domestic sources.....	573	9,5
Public:		
- *Local governments*	3	
- *Sitra*	5	
- *Kera*	1	
- *Other public funding sources*.....	3	
Private:		
- *Domestic funds*	4	
- *Other domestic units of the firm .(1)*.....	151	
- *Other domestic firms .(1)*.....	176	
- *Associations serving the industry*	7	
Loans:		
- *Kera*.....	43	
- *TEKES*)*	161	
- *Other borrower*	19	
Funding from abroad	94	1,5
- *Foreign units of the firm*.....	47	
- *Other foreign firms*.....	37	
- *EU*.....	7	
- *International organizations*.....	2	
- *Other foreign sources*	1	
BERD total.....	6 234	100
*) total TEKES' share (loans & grants) = 7,6 %		
Source: Statistics Finland, Science & technology 1995:1, Table 12.		

From the above table, data also for the following proposed indicators:
(1) II.2.2 Research within and between enterprises

I.3 Embodied knowledge (i/o analysis)

I.3a - high tech capital and intermediate inputs (domestically produced/ acquired from outside)

- Virtaharju & Åkerblom (1993) "Technology Intensity of Finnish Manufacturing Industries": Input-output analyses on total technology intensity (direct & indirect inputs) in manufacturing output exist. High tech inputs per industry would have to be calculated separately.

- Using statistics on technology flows between source and user industries, high tech inputs to the individual industries in the forest cluster have be compiled by the author (see table below) By the same procedure, high tech inputs could, in principle, be calculated for all main industries.

Table A.16. High tech flows to forest cluster in 1989, percentage shares of total technology

High tech source industry	User industry (forest cluster industries)				
	Wood	Furniture	Pulp, paper products	Publishing and printing	Pulp and paper making machines
Drugs.....	1.9	0.6	0.6	0.9	0.1
Computers, office machines.....	1.0	0.8	1.1	1.0	0.2
Electrical equipment for industry.....	2.3	2.9	2.8	4.9	1.6
Radio, TV, telecomm. equipment..	1.5	3.8	0.8	1.5	0.5
Instruments, optical equipment	0.9	1.4	0.7	0.7	0.5
Total.....	7.6	9.5	6.0	9.0	2.9
Average % of high tech inputs of total technology in the forest cluster: 7 %					
Source: Virtaharju & Åkerblom (1993): Total technology flows in 1989 (matrix of source by user industry), Appendix Table 6, pp. 104-105					

Table A.17. Total technology intensities of manufacturing output to final demand by source in 1989 (%)

Industry	Total technology intensities of manufacturing output to final demand by source in 1989 (%)					
	Direct	Domestic inter-mediate	Imported inter-mediate	Domestic capital	Imported capital	Total technology intensity
Total manufacturing	6.72	1.77	0.80	0.97	1.90	12.15
Data available by industry						
Source: Virtaharju & Åkerblom (1993) Appendix Table 5, pp. 101-103.						

I.3b - software (domestically produced/ acquired from outside)

- Data not available

I.4 Disembodied knowledge (citation analysis)

I.4a - patents (domestically produced/ acquired from outside)

- See Chapter 8 in the report.
- Basic patent data available from various sources
- Table provided by OST in the Country dossier for this project: "Characterization of technology production - European patent" (EPAT-EPO-INPI).
- Also possible to have data searches done at the National Board of Patents and Registration
- According to a Finnish SCI expert, Dr. Terttu Luukkonen from VTT Group of Technology Studies, SCI is not necessarily a good indicator for engineering sciences, because the publishing traditions in these sciences differ from those e.g. in medicine. (In engineering and technical sciences, publishing activity does not necessarily correlate with the research activity)

Table A.18. Patent applications in Finland in 1992 and in 1994

Year	Domestic applications: Private persons	Domestic applications: Organizations, firms	All domestic applications	Foreign applications
1992	803	1247	2050	3948
1994.....	938	1404	2342	3864

Source: STATISTICS FINLAND, Science & Technology 1995: 3

I.4b - scientific papers (domestically produced/ acquired from outside)

- Report by the Ministry of Education: "Scientific publications of the universities" (1994)
- Table provided by OECD (OST-Country Dossier)"Characterization of scientific production" (SCI-ISI)
- - Characterization of the scientific production (SCI):
Tables on pages 10 - 11 in OST-Country Dossier
- - 1. Share (proportion) of publications in eight disciplines (in the world)
- - 2. Index of specialization in eight disciplines
- - 3. Index of the impact of publications in eight disciplines

2. Indicators of the forms of knowledge sharing and transfer

- II.1.1 - 1.6 : universities, research institutes and industry
- II.2.1 - 2.5 : between suppliers and users

II.1.1 University-industry research centres (UIRCs)

- number and technological specialization of UIRCs
- magnitude of R&D effort associated with UIRCs

- Requires a survey among universities.

II.1.2 Bridging institutions

- Type and economic importance of bridging institutions

- Requires a survey among such institutions. Data could be collected from annual reports and brochures

II.1.3 Personnel mobility

- See Chapter 6 in the report.

spin-offs (firms created by academic researchers)

- See Chapter on 9 in the report.

II.1.4 Revealed advantage in transfer and engineering sciences

II.1.4a - Share of scientific publications in transfer science (Biblimetric data)

-Unclear how SCI searches should be done for this project (OECD should coordinate?)

II.1.5 Methods of learning in university-industry relations:

Importance of following sources or methods for learning about research conducted in universities for a business firm:

- university publications (for business firms)
- trained staff
- informal contacts
- contract R&D
- joint R&D
-etc.

- See Table 43 in Chapter 9 of the report.

II.1.6 University research output, delivered in suitable form for industrial use

- Intensity and specialization of universities' patenting activities
- % of researchers from universities having published studies and patent applications
- Amount of technical knowledge (e.g. software) produced and distributed without charge by universities

- See Chapter 5 in the report.
- This type of data is largely missing from the Ministry of Education.
- Universities' patenting activities are limited by legislation. Thus patenting activities resulting e.g. from joint university - industry R&D are difficult to study because it is usually the funding organization or the firm who appears as a patent applicant. In case the inventor is a university staff member, he or she is identified in the patent application only by name and home address and not by professional affiliation. Patents would have to be studied on a case by case basis.

II.2.1 Producer/ user interactions

- Some data exists in Statistics Finland innovation surveys.
- See also Chapter 4 in the report.

Table A.19. Firms conducting research cooperation by partner in 1991

Industry	All firms with innovation activities Total No.	Firms conducting R&D cooperation (1)							
		Total No.	%	w/ other units of the firm %	w/ custo-mers %	w/ other industrial firms %	w/ consulting firms %	w/ research organi-zations %	w/ univer-sities % (2)
Food, beverages, tobacco.....	284	88	31	19.7	11.3	12.4	6.6	12.2	8.2
Textiles.....	89	57	64.1	14.1	43.3	41.6	19.7	22.3	22.8
Wearing apparel, leather, footwear ..	187	82	43.9	4.4	28.7	15.5	21.2	5.9	5.9
Wood and wood products	168	39	23.0	6.1	16.7	15.0	7.9	11.7	4.6
Pulp and paper, paper products	40	33	81.3	66.9	59.7	48.5	38.6	48.0	42.0
Printing and publishing	154	46	29.9	7.3	10.0	15.5	3.4	8.4	7.3
Furniture	168	33	19.3	3.0	14.3	4.5	1.5	0.6	0.6
Chemicals.....	25	17	68	44	50	28	28	56	32
Petroleum, coal....	57	20	34.5	7.1	31.9	28.3	26.5	34.5	28.3
Rubber, plastic products.....	140	73	52	32.9	30.3	21.3	15.2	11.4	15.3
Glass, clay, stone products.....	127	73	57.3	20.3	27.2	34.1	14.1	18.5	10.1
Metals.....	44	30	68.5	27.9	45	32.2	11.5	51.4	39.2
Metal products.....	258	97	37.6	20.7	23	9.8	17.3	8.3	7.9
Machinery, equipment.....	360	138	38.2	20.2	22.9	12.3	10.1	13.3	11.9
Electrical products, instruments.....	194	121	62.4	32	28.3	39.9	16.8	38.8	40.1
Transport equipment.....	142	32	22.8	13.9	13.4	16.7	7	2.8	4
Other manufacturing	71	45	62.6	14.7	47.1	44.2	12.8	11.9	11.9
Manufacturing sector totals	2509	1022	40.7	17.8	23.6	19.5	12.4	14.8	12.9

Source: Åkerblom (1992) Statistics Finland, Innovation survey of 1991, Table 5A

From the above table, data also for the following proposed indicators:
(1) II.2.2 Research within and between enterprises: Firms reporting research cooperation by partner
(2) II.1.5 Methods of learning in university-industry relations: importance of following sources or methods for learning about research conducted in universities for a business firm: II.1.5g - joint R&D

Table A.20.. Share of firms regarding an innovation source as important

Source	%
Top management	61
Internal R&D	69
Marketing	70
Production	39
Customers	88
Fairs	37
Competition	82
Material technology	45
Immaterial technology	23
Subcontractors	29
Universities	24
R&D institutes	12

Leppälahti-Åkerblom (1991) Industrial innovation in Finland.

From the above table, data also for the following proposed indicators:
(1) II.2.2 Research within and between enterprises: Firms reporting research cooperation by partner
(2) II.1.5 Methods of learning in university-industry relations: importance of following sources or methods for learning about research conducted in universities for a business firm: II.1.5g - joint R&D

II.2.2 Research within and between enterprises: Firms reporting research cooperation by partner

II.2.2a- Intra-firm business cooperation (between business units)
II.2.2b- between firms (horizontal)
II.2.2c - between firms (vertical)
II.2.2d- consultants
II.2.2e - technical research institution in specific industries
II.2.2f - relative importance of institutional forms of cooperative research, like joint ventures, technological cooperation in specific industry, large cooperative programmes involving multidisciplinary research
II.2.2g - importance of informal networks, as a key mechanism for sharing knowledge

- Some data exists in Statistics Finland innovation surveys.
- See also Chapter 4 in the report.

Table A.21. Firms conducting research cooperation by geographical distribution in 1991

Industry	All firms with innovation activities Total No.	Firms conducting R&D cooperation								
		Total No.	%	w/ Finnish counterparts %	w/ counterparts from Nordic countries %	w/ counterparts from EU %	w/ other European counterparts %	w/ U.S. counterparts %	w/ Japanese counterparts %	w/ other counterparts %
Manufacturing sector totals .... Data available by industry	2509	1022	40.7	38.7	13.1	14.0	4.6	7.2	1.3	1.2
Source: Åkerblom (1992) Statistics Finland , Innovation survey of 1991, Table 5A										

Table A.22. Participation in international R&D programs by the R&D units of the firms: large concerns, large and medium-sized firms in Finland

	All surveyed R&D units				
	No. of units	% w/ internat R&D prog-rams	EU-REKA %	EU %	Other programs %
All large concerns in the survey..... All large & medium-sized firms in the survey	282 204	32 13	14 5	11 5	16 4
Source: Åkerblom (1994) Statistics Finland, Internationalization of the Finnish firms' R&D, Tables 10-11.					

Table A.22. (Table continued)

	All surveyed R&D units									
	Domestic R&D units					Oversears R&D units				
	No. of units	% w/ internat R&D prog-rams	EURE KA %	EU %	Other prog-rams %	No. of units	% w/ internat R&D prog-rams	EURE KA %	EU %	Other prog-rams %
All large concerns in the survey..... All large & medium-sized firms in the survey	182	33	17	10	16	101	30	8	11	14

From the above table, data also for the following proposed indicators:

II.2.2 Research within and between enterprises: Firms reporting research cooperation by partner: II.2.2f - relative importance of institutional forms of cooperative research, like joint ventures, technological cooperation in specific industry, large cooperative programmes involving multidisciplinary research

II.2.3 Importance of property right system in knowledge transfer and distribution

II.2.3a - % of business R&D expenditures resulting in intellectual property rights
II.2.3b - economic effects of intellectual property rights
II.2.3c - cross-licensing activities

- See Chapter 8 in the report.
- Some general studies are available, e.g.a Ministry of Trade and Industry publication "Significance of the patent system for the national economy and industrial policy" and Mansala "Industrial property rights as part of a firms' strategy in the integrating market". Data is mainly qualitative in these studies.

- See Table 49 *(Acquisition of technology in firms with innovative activity in 1991)* , Table 50 *(Firms with acquisition of technology by partner in 1991)*, Table 51 *(Sale of technology by firms with innovative activity in 1991)* and Table 52 *(Firms with sale of technology by partner in 1991)* in Chapter 10, which contains figures for the forest cluster industries and for the whole manufacturing sector. Data is also available for other industries.

II.2.4 Participation in standardization activities

- By the end of 1994, there were 267 SFS-ISO 9000 (EN 29000) certifications on quality systems in Finland.

- Of all firms applying for SFS-ISO (EN 29000) system certification in Finland in 1994, about 18 % represented the industries of pulp, paper and board manufacture (see Table below). List of individual firms with certification has been made available from the SFS.

Table .A.23.Distribution of firms with SFS-ISO 9000 certification (or w/ certification application) by industry in 1994

Industry	%

Pulp, paper and paperboard manufacture	18
Information technology	13
Electrical industry	10
Chemistry	12
Transport	9
Trade	6
Consultancy & Engineering firms	6
Metals	6
Rubber and plastics	5
Wood and wood products	5
Construction	2
Other sectors	8

Source: SFS (Standardization Association of Finland) Annual Report 1994.

II.2.5 Orientation of technology and innovation policy towards diffusion

II.2.5a - Relative amount of money allocated towards diffusion at both national and regional levels

- Funding statistics from S&T policy organizations, especially TEKES, is available e.g. on national technology and other programmes, industrial R&D.

3. Indicators of the effectiveness of knowledge sharing and transfer

- III.1.1 - 1.3: universities, research institutes and industry
- III.2.1: between suppliers and users

III.1.1 Intensity of use of university knowledge-base by business firms

III.1.1a - importance of technical knowledge obtained from universities to the innovative activities of firms

- See Chapters 4 and 9 in the report.
- Some data exists in Statistics Finland innovation surveys. Would require a special survey.

III.1.1b - academic citations: frequency used in corporate patents

- Data searches on can, in principle, be performed at the National Board of Patents and Registration but they are expensive.

III.1.2 Cooperative R&D between university and industry

III.1.2a - No. of formal cooperative projects between university and industry
III.1.2b - joint turnover of the above
III.1.2c - intensity of co-patenting between universities and industry
III.1.2d - technological specialization of the above
III.1.2e - intensity of co-publication between university and industry
III.1.2f - technological specialization of the above

- See Chapter 5.
- a-b) Requires a survey among universities.
- c-d) & e-f) OECD should provide bibliometric and patent data. Refer to problems with finding out inventor's affiliation mentioned earlier

III.1.3 Industrial contribution to basic research
III.1.3a - share of business firms in total expenditure on basic research
III.1.3b - No. of relevant publications by industrial researchers

- Some statistics on industrial contribution to university research exists at Statistics Finland (confidential info).

- A study by Halinen & Räty (1994) "Ulkopuolisen rahoituksen yliopistotiedettä suuntaava vaikutus" (The impact of outside funding on university science): the case of the University of Helsinki) The publication has some statistics on outside funding on one university, but does not specify whether this funding has been directed at applied or at basic research at the university..

III.1.4 Distribution of knowledge among competitors and between suppliers and users

III.1.4a - diffusion rate of new products and processes
III.1.4b - diffusion rate of specific high-tech products

- Recent studies indicate that, although the number of ISO 9000 certificates has increased lately and the level of adoption of advanced manufacturing technologies, such as FMSs, and the use of information technology are on a high level in the Finnish manufacturing, these changes have often been limited only to general operations and strategies while the actual production is still often organized according to the old hierarchial principles and work methods (Vuori & Vuorinen 1994, Alasoini 1995). Also a Statistics Finland survey (Leppälahti & Åkerblom 1991) indicated that the worker initiative system has not been considered as a significant source of innovation ideas by firms. It is likely, however, that these observations apply more for sectors representing traditional industries (e.g. shipbuilding) and not for the fast-growing telecommunications and similar industries.

- References exist e.g. in the following sources:
- - "Made in Europe: A Four Nations' Best Practice Study" by IBM UK Ltd. & London Business School (1994).
- - The International Manufacturing Strategy Survey (IMSS). The Finnish data has been made available from VTT Automation . 91 units were surveyed with 19 % (17 answers) response rate; yet "reasonable picture of Finnish SIC 38 industry".
- - A SITRA Publication (1990) "Flexible production and the network-based economy: interactions between technology, economy and society in the 1990s"
- - "The new industrial Finland" by Eloranta, Ranta, Ollus & Suvanto (1994)
- - World Industrial Robot Statistics 1992 by United Nations
- - World Engineering Industries and Automation: Performance and Prospects 1992-1994 by United Nations

- - Finnish Robotics Statistics in 1994 by Robotics Society in Finland
- - "Development of industrial robotics in Finland" by J. Ingman, VTT Automation (1994)

Table A.24. New products and substantial improvements of old products in proportion to turnover in 1991

Industry	Proportion of turnover of:	
	New products (introduced within the past 3 yrs in the market)	Substantial improvements of old products
Food, beverages, tobacco	8	9,2
Textiles	19,9	14,9
Wearing apparel, leather, footwear	21,7	24,7
Wood and wood products	8,9	13,3
Pulp and paper, paper products	3,2	10,4
Printing and publishing	8,8	5,7
Furniture	10,9	17,9
Chemicals	4,8	15,4
Petroleum, coal	7,3	9,6
Rubber, plastic products	9,4	17,5
Glass, clay, stone products	20,5	16,1
Metals	2,8	5,9
Metal products	6,7	12,6
Machinery, equipment	15,4	26,9
Electrical products, instruments	29,3	27,5
Transport equipment	9,8	32,8
Other manufacturing	11,4	15,2
Manufacturing sector totals	10,9	14,9

Åkerblom (1992) Statistics Finland, Innovation survey of 1991, Table 9A

Table A.25. Distribution of R&D expenditures into product and process development activities in the unit as a percentage of BERD in 1993

Industry	Product development %	Process development %	R&D not directly related to development of products / processes in the firm (%)
Manufacturing sector average	78.5	18.5	3.0
.....			
Data available by industry			

Source: Statistics Finland, Science & technology 1995:1, Table 13.

- See also tables on pp. 16 - 21 in OST's Country-dossier:
- - Internationalization of scientific production (2 tables)
- - The scientific partners of the country (3 tables)

4. Indicators of the economic impact of knowledge sharing and transfer

Correlation of the measures of the effectiveness of knowledge sharing and transfer to some measures of economic performance, i.e. international competitiveness, specialization profile and employment trends, R&D efficiency.

IV.a Effects of technology inputs on productivity

- Vuori's study (Vuori 1995) on the technology sources of Finnish manufacturing contains an econometric analysis of the use of various technology sources on industry-level total factor productivity (TFP). The results were the following: in 1981-1985 the most important technology factor affecting TFP growth positively was technology embodied in foreign capital goods, in 1985-1989 technology embodied in domestic intermediate goods and in 1989-1993 direct technology i.e. intramural R&D. Furthermore, the regression results implied that an increase of 1 % in the technology stock built by means of own research activities increased productivity by 0.3-0.5 %. Tentative analysis also indicated that the returns to process development, in general, would be far higher than the returns to product development.

Table A.26. Percentual development in the mobility of research personnel at VTT [2]
(Table continued on the next page)

Mobility of personnel at VTT by division and research unit (%)	mobility-% in 1994 (No. employed during the whole year)
- Electronic circuits & systems	17,5 (45)
- Electronic materials & components	8,6 (60)
- Embedded software	6,1 (42)
- Optoelectronics	3,2 (58)
VTT Electronics	8,9
- Information systems	22,4 (39)
- Telecommunicatios	22,5 (50)
- Multimedia systems	15,8 (40)
- Printed communications	19,6 (36)
- Health care technology	n.a.
VTT Information technology	20,1
- Industrial automation	5,6 (50)
- Machine automation	15,5 (48)
- Space technology	9,4 (56)
- Measurement technology	6,8 (27)
- Electrotechnical testing	2,8 (35)
VTT Automation	8,7
- Polymer and fibre technology	8,7 (47)
- Environmental technology	2,2 (42)
- Process technology	12,4 (47)
- Mineral processing	0 (21)
- Chemical analysis	7,3 (47)
VTT Chemical engineering	7,9
- Biotechnology	0 (32)
- Genetic engineering	4,9 (35)
- Brewing technology & plant biotechnology	8,1 (33)
- Microbiology	7,3 (37)
- Food technology	1,6 (58)
VTT Biotechnology & Food research	5,7

[2] REF: Section 6.6 Human capital and mobility at VTT / Source: VTT

Table A.26. (table continued) Percentual development in the mobility of research personnel at VTT

Mobility of personnel at VTT by division and research unit (%)	mobility-% in 1994 (No. employed during the whole year)
- Energy production technologies:	
-- Poltto- ja konversiotekniikat	1,4 (72)
-- Biopolttoaineet	5,1 (72)
- Energy use:	6,5 (13)
-- Moottoritekniikka	0 (19)
- Nuclear energy	0 (71)
- Energy systems	2,5 (38)
VTT Energy	2,6
- Safety engineering	5,3 (69)
- Production engineering	11,7 (66)
- Materials technology	10,3 (49)
- Materials and structural integrity	16,7 (107)
- Maritime and mechanical engineering	2,8 (66)
VTT Manufacturing technology	10,2
- Building physics, services and fire technology	
- Construction and facility management	
- Strategic technology development	
- Building materials and products, wood technology	
VTT Building technology	6,6
- Urban planning	
- Transport research	
- Road engineering and geotechnology	
- Rock and environmental engineering	
VTT Communies & Infrastructure	6,7
Average mobility-% for personnel at VTT	7,8

APPENDIX 2.

List of the proposed indicators

Below is the list of the indicators proposed by the OECD (DSTI/STP/TIP(94)16/REV) for the pilot studies. Included are four main types of indicators for measuring the distribution power of the national innovation systems: (i) Indicators of the stocks and flows of knowledge, (ii) Indicators of the forms of knowledge sharing and transfer, (iii) Indicators of the effectiveness of knowledge sharing and transfer, and (iv) Indicators of the economic impact of knowledge sharing and transfer.

I. Indicators of the stocks and flows of knowledge

I.1 Learning through training
I.1a - formal training provided by employers (intensity, distribution by type of firm/ technology)
I.1b - science and engineering personnel (total national stock and breakdown by sector and type of employment)

I.2 Learning by doing
I.2a - cumulative R&D expenditures (distribution by type of firm/technology)

I.3 Embodied knowledge (i/o analysis)
I.3a - high tech capital and intermediate inputs (domestically produced/ acquired from outside)
I.3b - software (domestically produced/ acquired from outside)

I.4 Disembodied knowledge (citation analysis)
I.4a - patents (domestically produced/ acquired from outside)
I.4b - scientific papers (domestically produced/ acquired from outside)

II. Indicators of the forms of knowledge sharing and transfer

II.1.1 - 1.6 : universities, research institutes and industry
II.2.1 - 2.5 : between suppliers and users

II.1.1 University-industry research centres (UIRCs)
II.1.1a - number and technological specialization of UIRCs
II.1.1b - magnitude of R&D effort associated with UIRCs
II.1.1c - number and type of university faculty, research scientists and students associated with UIRC acitivities
II.1.1d - importance of educational functions of UIRCs (No. oof students affiliated with UIRCs being hired by participating firms)

II.1.2 Bridging institutions
II.1.2a - Type and economic importance of bridging institutions

II.1.3 Personnel mobility
II.1.3a - Rates of mobility from university and research institutes to enterprise sector
II.1.3b - recruitement and destinations of university personnel when leaving university
II.1.3c - partial mobility (sabbaticals, contract research, mixed research positions)
II.1.3d - spin-offs (firms created by academic researchers)

II.1.4 Revealed advantage in transfer and engineering sciences
II.1.4a - Share of scientific publications in transfer science (Biblimetric data)

II.1.5 Methods of learning in university-industry relations: importance of following sources or methods for learning about research conducted in universities for a business firm
II.1.5a - university publications (for business firms)
II.1.5b - conferences
II.1.5c - trained staff
II.1.5d - informal contacts
II.1.5e - temporary exchanges
II.1.5f - contract R&D
II.1.5g - joint R&D

II.1.6 University research output, delivered in suitable form for industrial use
II.1.6a - Intensity and specialization of universities' patenting activities
II.1.6b - % of researchers from universities having published studies and patent applications
II.1.6c - Amount of technical knowledge (e.g. software) produced and distributed without charge by universities

II.2.1 Producer/ user interactions

II.2.2 Research within and between enterprises: Firms reporting research cooperation by partner
II.2.2a - Intra-firm business cooperation (between business units)
II.2.2b - between firms (horizontal)
II.2.2c - between firms (vertical)
II.2.2d - consultants
II.2.2e - technical research institution in specific industries
II.2.2f - relative importance of institutional forms of cooperative research, like joint ventures, technological cooperation in specific industry, large cooperative programmes involving multidisciplinary research
II.2.2g - importance of informal networks, as a key mechanism for sharing knowledge

II.2.3 Importance of property right system in knowledge transfer and distribution
II.2.3a - % of business R&D expenditures resulting in intellectual property rights
II.2.3b - economic effects of intellectual property rights
II.2.3c - cross-licensing activities

II.2.4 Participation in standardization activities

II.2.5 Orientation of technology and innovation policy towards diffusion
II.2.5a - Relative amount of money allocated towards diffusion at both national and regional levels

III. Indicators of the effectiveness of knowledge sharing and transfer
III.1.1 - 1.3: universities, research institutes and industry
III.2.1: between suppliers and users

III.1.1 Intensity of use of university knowledge-base by business firms
III.1.1a - importance of technical knowledge obtained from universities to the innovative activities of firms
III.1.1b - academic citations: frequency used in corporate patents

III.1.2 Cooperative R&D between university and industry

III.1.2a - No. of formal cooperative projects between university and industry
III.1.2b - joint turnover of the above
III.1.2c - intensity of co-patenting between universities and industry
III.1.2d - technological specialization of the above
III.1.2e - intensity of co-publication between univeristy and industry
III.1.2f - technological specialization of the above

III.1.3 Industrial contribution to basic research

III.1.3a - share of business firms in total expenditure on basic research
III.1.3b - No. of relevant publications by industrial researchers

III.1.4 Distribution of knowledge among competitors and between suppliers and users

III.1.4a - diffusion rate of new products and processes
III.1.4b - diffusion rate of specific high-tech products

IV. Indicators of the economic impact of knowledge sharing and transfer

Correlation of the measures of the effectiveness of knowledge sharing and transfer to some measures of economic performance, i.e. international competitiveness, specialization profile and employment trends, R&D efficiency.