EUEREK
EUROPEAN UNIVERSITIES FOR ENTREPRENEURSHIP
– THEIR ROLE IN THE EUROPE OF KNOWLEDGE –

KTH

EUEREK Case study, Sweden

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KTH
VETENSKAP
OCH KONST

ROYAL INSTITUTE
OF TECHNOLOGY

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Introduction

KTH (Kungliga Tekniska högskolan, the Royal Institute of Technology) was founded in 1877 from the Technological Institute of Stockholm, which had come into existence in 1827. Around KTH and its predecessor there has been a continual dynamic for being popular and practical, with a growing scholarly dimension. In 1927 KTH was affirmed as Sweden's premier higher education institution for technology and engineering when it was granted the ability to confer the Doctor of Technology degree. From a start in Mechanical Engineering, Chemical Technology & Engineering, and Civil Engineering, other fields have been steadily added: Mining Science (1867), Building Architecture (1877), Electrical Engineering (1901), Naval Architecture (1912), Surveying & Engineering Physics (1932), Computer Science (1983), and Industrial Economics (1990). About one third of Sweden's annual crop of engineers graduate from KTH. It is now a world-class public university with five campuses centered around Stockholm, Sweden. It has 12,642 students, 3002 employees, and an annual turnover of €320 million (Annual report 2004).

KTH has been extremely proactive in developing their outreach activities. A primary activity that we have been monitoring is the KTH Entrepreneurial Faculty project. This bottom-up project is highly novel, not least for the fact that it is being directed by and belongs to the KTH faculty rather than the university management / administration. The project is ongoing, and involves a range of people from industry, government and academia, from both Sweden and abroad. Benchmarking study visits "to inspire and to scare" involving some 60 people from Sweden were accomplished to the UK (Surrey & Cambridge Universities), the Netherlands (Twente & Delft), the USA (MIT & Tufts), Switzerland (ETH Zurich & EPF Lausanne) and to Finland (Helsinki Univ. of Technology). They held a two-day open seminar of some 300+ people in Stockholm in April 2005, with invitees from most of the above institutions and with wide participation from industry. There has been an ongoing string of further seminars in Autumn 2005 (the most recent, 14 Dec. 2005 titled "Professors of the Next Generation"). They have sought out what has really worked elsewhere, and how it might be adapted to conditions at KTH and Sweden.

A 125-page summary of KTH's Entrepreneurial Faculty project was published in late November 2005 by Vinnova, the Swedish Agency for Innovation Systems (Källblad et al. 2005). We believe that this work should be extremely interesting to our EUEREK efforts, in part for its example as an analytical format, and in part as an example of self-reflection in Swedish Higher Education (all the more rare in that it is published in English). Rather than mediate and paraphrase, we have attached the report as the bulk of this case study.

University mission

In Sweden a university's mission is defined by law. Since the Higher Education Act of 1977, Swedish universities have been responsible for education, research, and also "informing society about research." But revisions in the Higher Education Act in 1996 were more explicit and interactive for the last case, designating that universities should "co-operate with the surrounding community and inform about its operations" ("samverka med det omgivande samhället och informera om sin verksamhet" SFS 1996:1392), thus requiring collaboration with society. Sweden's universities now are thus required to pay attention to this so-called "third task" (in Swedish, "tredje uppgiften"). This is not simply an outflow, or a trickle down effect, but a development resulting from interactive dialogue. Many argue,

however, (and it was regularly mentioned spontaneously in our interviews) that this cooperation with society is not necessarily something wholly distinct from education and research; it may rather be a grounded way of handling education & research, and infusing education and research, so those activities are responsive and interactive with the wider world.

University priorities

The KTH Entrepreneurial Faculty project has been built around six themes that are deemed highly important for the university's strategy, and for achieving their mission:

- **Vision and Culture**
- **University-Stakeholder Relations**
- **New Support Systems for Innovation**
- **Alliances**
- **Communication**
- **Management, Organisation and Funding**

KTH's "Future Faculty Project" is operating in parallel to their "Entrepreneurial Faculty Project." This "Future Faculty" effort aims to make KTH a highly attractive environment for work. Reportedly, KTH is often seen as grey, technical, and predominantly male. A further area that is both a strength and a weakness is the strong relationship of KTH to large Swedish industries. While this relationship is good, it contrasts with a less developed interaction between the university and SMEs and spinoff firms. This is important because the university itself wishes to be entrepreneurial, to be more than "a hotel for faculty," and to be an active participant in both national and regional innovation systems. Some at KTH expect that this will involve new types of competition and incentives. New emphases include the diversification of faculty and relaxation of faculty job rigidities, including the recruitment of female professors (and students). They ask if some future faculty members might not prefer a part-time commitment, or best be allowed to interrupt careers for an extended sabbatical. They look at the incentives and attractions of university careers in comparison to working elsewhere. Are there better ways to advantageously position academia? What wholesome dimensions of life does academia negatively impact? For example, can a professor earn enough to hire home support? Many scholar families delay having children, or forego it completely due to studies and work challenges; can this be remedied? These are important questions. Though in many market-driven industries these issues are considered peripheral to work, at the same time other organizations worldwide are adjusting. They have found that they are more attractive to recruits and for staff retention if they can offer, for example, an at-work crèche for childcare.

The "Future Faculty Project" has an annual budget of 10 million sek and is headed by one of the two Vice Presidents (Pro-rectors) of KTH, who are appointed by the University Board. The project reportedly benefits from this connection, as the Vice President (Margareta Norell Bergendahl, Professor of Integrated Product Development, Department of Machine Design) is able to drive effective change due in part to this expressed interest by the Board. Each of the nine schools at KTH has its own management group and Dean, who tend to be quite strong; there is much territoriality and considerable friction over who should initiate issues. While there has not in the recent past been such a broad effort to develop teams, to cultivate star researchers, and to tolerate more of a sense of risk within the organization, the goal to make the university more attractive is advancing. There is a hope to grow away from bulk education and narrow rigid programs, and to bring in more reflection, synthesis, and future-oriented initiatives. There is also the recognition that KTH should be more international. While international faculty at KTH is now 11%, top universities elsewhere often have 50% interntional fculty.

The university introduces some of its other its collaborative activities as follows (KTH Annual Report 2004., p. 2):

> "KTH has developed a joint project with Stockholm University concerning education and research within biotechnology and physics at AlbaNova located at Roslagstull. KTH also jointly runs the IT University at Kista campus as well as subsidiary campuses in Haninge, Flemingsberg and Södertälje. At the IT University, which is Sweden's major IT resource, KTH cooperates with Stockholm University, Karolinska Institutet, other research institutes and industry. KTH implements extensive research and educational exchanges with universities and colleges in Europe and worldwide. Cooperating countries include those in Europe, Southeast Asia, Australia as well as the USA. Exchanges with Eastern Europe are also increasing, especially with the Baltic States and Russia. The university participates in various EU programmes and manages a large number of international projects. Activities are also undertaken in cooperation with the Swedish International Development Cooperation Agency (Sida)."

Net Registered Students, KTH University

	Part time	Full time	Total			Part time	Full time	Total
Spring 05	5570	7642	13212		Spring 99	3625	7545	11170
Autumn 04	5307	8888	14195		Autumn 98	3233	8384	11617
Spring 04	5239	8000	13239		Spring 98	3032	7248	10280
Autumn 03	5013	9105	14118		Autumn 97	3462	8353	11815
Spring 03	4871	7532	12403		Spring 97	3700	7013	10713
Autumn 02	4582	8422	13004		Autumn 96	3371	8046	11417
Spring 02	4000	7489	11489		Spring 96	3772	5945	9717
Autumn 01	3435	8453	11888		Autumn 95	3778	6788	10566
Spring 01	3190	7496	10686		Spring 95	6651	1873	8524
Autumn 00	3379	8185	11564		Autumn 94	2701	6933	9634
Spring 00	3085	7631	10716		Spring 94	5906	2188	8094
Autumn 99	3396	8157	11553		Autumn 93	2592	6756	9348

Data: as reported by the university to Sweden's National Agency for Higher Education, Högskoleverket

KTH - Royal Institute of Technology: Competitiveness of entry

	term	Applicants Sökande	Available Places Platser	Competition rate for each place Söktryck	
				at KTH	national average
Entry to all programs (totals) Summan av alla utbildningspgm.	Spring 2006 VT06	715	345	2,1	3,2
	Autumn 2005 HT05	4637	2620	1,8	2,3
	Spring 2005 VT05	276	250	1,1	3,4
	Autumn 2004 HT04	4711	2770	1,7	2,2
	Spring 2004 VT04	253	250	1,0	3,4
	Autumn 2003 HT03	4707	3025	1,6	2,1
	Spring 2003 VT03	159	60	2,7	3,1
	Autumn 2002 HT02	4741	2906	1,6	2,1
	Spring 2002 VT02	n.a.	n.a.	n.a.	3,5
	Autumn 2001 HT01	4939	2850	1,7	2,2

Data: as reported by the university to Sweden's National Agency for Higher Education, Högskoleverket

KTH is highly active internationally. But when compared to the top international universities such as MIT, Cal Tech and Cambridge, perhaps KTH is still second tier. A very large proportion of the classes are taught in Swedish, and the faculty is overwhelmingly Swedish, though there is a clear trend and emphasis on becoming more deeply international.

A dimension of Swedish universities perhaps uncommon elsewhere is that the government can steer certain policy dimensions that are fully faculty-controlled in many academic systems. KTH mentions in their *Annual Report 2004* (p. 28) that "the Government has stated that 828 doctoral degrees must be awarded for studies at KTH during the period 2001–2004, and that at least 13 percent of all professors appointed during the same period must be women." If such goals can be achieved without sacrificing quality or academic standards, then wonderful. But if people are hired solely to address gender imbalances, or doctoral degrees are conferred prematurely, or for substandard performance, such goals could be highly problematic.

KTH	**Exchange & international students: incoming and outgoing** IN- OCH UTRESANDE STUDENTER NETTO PER HÖGSKOLA				
	Incoming	Change from prior year	Outgoing	Change from prior year	Incoming / Outgoing
2004	901	+16%	665	+10%	135%
2003	775	+6%	604	+8%	128%
2002	734	+16%	560	-13%	131%
2001	631	+12%	642	+7%	98%
2000	562	-3%	598	+17%	94%
1999	580	+14%	512	+9%	113%
1998	508	+40%	469	-4%	108%
1997	363	--	490	--	74%

Data: as reported by the university to Sweden's National Agency for Higher Education, Högskoleverket

KTH describes their own spinoffs and startup activities as follows (*Annual Report 2004*, p. 28):

> "Innovation activities and business contacts: KTH's innovation activities offer researchers and students the competence and support necessary for the development of results and innovations originating from basic research activities. KTH's Start-up House offers a development and introduction period for these projects, free office space including computer and telephone, plus an entrepreneurial environment. These services may be utilised for a period of six to twelve months free of charge. The financing of KTH's Start-up House comes from the Stockholm Foundation of Technology Transfer. Since its inauguration in 2001, 22 projects have passed through the Start-up House. In 2004, seven projects have been located there. Over 100 advisory matters have been dealt with of which 30-40 concerned patents. In the autumn of 2004 cooperation was initiated with Kista Innovation & Growth (KIG) with the aim of developing operations to also include an incubator - the next step after the Startup House concept. This cooperation lead to the establishment of an agreement concerning incubator operations between KTH and KIG. This new project is financed by VINNOVA."

One of the areas where KTH is highly innovative is in their planning and partial redesign of the main campus and its surroundings. From the most recent Annual Report 2004, p. 32:

> "During the period 2004–2008, focus will lie on continued planning and design of an attractive outdoor environment – roads, squares and spaces – as well as a well-functioning, good quality inside environment. KTH’s Land and Real Estate Development Plan, UBM 2004, shows how by increasing the density of the roadside environments with new buildings, more of a village spirit can be created and the preconditions established for activities in the area throughout most of the day and night. In order to improve contact with other parts of the university belt i.e. Stockholm University and Albano, and to upgrade connections between the academic world and the National City Park, the plan also proposes an “Academic Highway” with clearly marked entrance points from Valhallavägen and Roslagsvägen."

These are highly interesting plans. KTH is also participating with other area universities in the redesign of Stockholm's northern beltway into a new Norra Station & Stockholm Bioscience subcity, perhaps the largest and most ambitious city project of the coming 15 years. There are expected to be huge positive direct impact on internationalization, with novel educational opportunities and coordination in the region's new combined megacampus and science park, and with many positive spillover effects for the wider economy as well.

Worrisome difficulties cited repeatedly by people and in reports include the following :

> "A clear career path after graduation for those completing their doctoral studies is a vital prerequisite for retaining and developing core competence in the long term. There is a good supply of newly graduated doctors. It is therefore worrying that KTH, due to lack of funding, cannot employ more research associates and associate lecturers and that this category of staff has more than halved in number since 1999."
>
> - Annual Report 2004, p. 31

This is one of the areas of improvement targeted by the KTH Future Faculty Project.

In terms of electronic learning and distance education, Sweden's universities are cooperating via a national Swedish Net University, exchanging information, know-how, and jointly providing a search platform of course offerings (http://www.netuniversity.se). The project offers 2600 courses, including about 150 in English, from 35 universities and university colleges. Registration is with each individual provider; some require a physical attendance component; and as with regular courses in Sweden, no tuition is charged. To give some idea of relative activity in this field among our cases, (as of 2005-12-04) Umeå lists 124 such courses, Lund 93, KTH 41, and Jönköping 16.

KTH admissions to specific programs (recent totals)

		Autumn 2005			Spring 2006		
		Applicants Sökande	Available places Platser	Competition rate for each place Söktryck	Applicants Sökande	Available places Platser	Competition rate for each place Söktryck
Arkitekt	Architecture	588	60	9,8			
Basår		767	620	1,2	280	210	1,3
Civilingenjör	Master of engineering	2631	1260	2,1			
Högskoleingenjör		572	620	0,9	127	135	0,9
Lärare	Teaching	79	60	1,3			
Övriga program	Other programs				308	0	0

Data: as reported by the university to Sweden's National Agency for Higher Education, Högskoleverket

Summary:

KTH's sense of active entrepreneurialism is perhaps most apparent in its wide choice of top benchmarking comparisons. Most top institutions in Sweden have been rather satisfied until now if achieving national or Nordic regional excellence. Many individual scholars around Sweden are globally at the top of their fields, but their organizations are often rigid and provincial. KTH's use of Cambridge and MIT as comparisons bodes well for its future. But while the university has already accomplished a great deal with their Entrepreneurial Faculty Project in terms of priming expectations, the commitment of resources is quite modest and temporary: Technology Bridge and Vinnova provided funds, matched by KTH, that total approx. 3 million sek, or one tenth of one percent of their overall budget. The Future Faculty Project is better funded, but it is still a rather minor commitment if compared, for example, to the University of Singapore's efforts at strategic repositioning. Nonetheless, both projects are involving many key people, and are good steps in a positive direction.

KTH University finances (in thousand of kronor)

	2004	2003	2002	2001	2000	1999	1998	1997	1996	95/96	94/95
Income **Verksamhetens intäkter**											
Income from national appropriations (block grant) Intäkter av statsanslag	1512019	1486261	1416701	1330123	1299791	1217153	1179293	1120274	1165659	1725678	1107067
Income from county council appropriations Intäkter av landstingsanslag											
Income from fees and other payments Intäkter av avgifter och andra ersättningar	239593	256432	245473	277874	279464	283241	180143	143589	154924	227617	168037
Income from other allowances, subsidies & grants Intäkter av bidrag	975154	981445	983336	851946	813884	789820	855567	760003	680721	975279	619805
Financial (deposit / investment) income X1 Finansiella intäkter	6191	8183	12770	12928	6131	7425	17324	27395	66125	110051	49252
work income total A Summa verksamhetsintäkter	2732957	2732321	2658280	2472870	2399270	2297639	2232327	2051261	2067429	3038625	1944161
Costs **Verksamhetens kostnader**											
Personnel costs Personalkostnader	1635676	1630346	1540773	1400018	1417819	1320514	1284966	1173240	1079535	1554647	885260
Office space overheads Lokalkostnader	530920	503786	509997	474877	418016	379207	347349	342131	340492	509762	329524
Clinical educ & research Ers t landsting/kommuner för klinisk utb och forsk											
Other operating costs Övriga driftskostnader	403358	420508	457779	432749	382056	415581	509338	526597	490861	683568	424519
writeoffs & deductions Avskrivningar	156802	170932	174304	165599	181217	189602	181618	148314	124428	176317	111417
Financial costs X2 Finansiella kostnader	11166	15833	19384	15183	15166	14443	17172	13125	17487	24856	10330
work costs total B Summa verksamhetskostnader	2737923	2741406	2702238	2488426	2414274	2319347	2340443	2203407	2052803	2949150	1761050
Result **Verksamhetsutfall**											
results of activities (from 1999, A - B) Verksamhetsutfall	-4965	-9086	-43959	-15556	-15004	-21708	-108268	-166416	-34012	4280	144189
Årets kapitalförändring											
capital value change over year (1998 & earlier, A - B) Årets kapitalförändring	-5501	-10685	-43805	-15548	-15002	-22843	-108724	-152146	14626	89475	183111

Note: Financial income and costs (X1 & X2) are part of results (Verksamhetsutfall) from 1999; earlier they are treated separately and totalled in Capital value change over year (Årets kapitalförändring)

KTH Personnel Numbers (Kungl. Tekniska högskolan)

(full time equivalents / heltidsekvivalenter)			Male	Female	Total
Administrative personnel	(*Administrativ personal)*	2004	436,3	203,9	640,2
	" "	2003	463,8	209,5	673,3
	" "	2002	405,8	131,8	537,6
	" "	2001	382,1	112,5	494,6
	" "	2000	402,1	119,0	521,0
	" "	1999	415,2	112,3	527,5
	" "	1998	403	117	520
	" "	1997	387	111	498
	" "	95/96	367	93	460
	" "	94/95	338	84	422
	" "	93/94	337	87	424
Library personnel	(*Bibliotekspersonal*)	2004	22,1	8,6	30,8
	" "	2003	27,6	8,8	36,5
	" "	2002	34,9	9,8	44,7
	" "	2001	32,9	10,1	43,0
	" "	2000	36,7	11,9	48,6

	" "	1999	35,8	11,8	47,5
	" "	1998	36	13	49
	" "	1997	33	13	46
	" "	95/96	34	18	51
	" "	94/95	32	15	47
	" "	93/94	35	16	51
Technical personnel	(*Teknisk personal*)	2004	73,0	298,6	371,6
	" "	2003	73,8	340,7	414,4
	" "	2002	91,6	454,5	546,1
	" "	2001	86,1	418,4	504,4
	(*Teknisk/övrig personal*)	2000	71,3	262,6	334,0
	" "	1999	68,2	267,7	336,0
	" "	1998	68	261	329
	" "	1997	70	237	307
	(*Teknisk personal*)	95/96	76	222	298
	" "	94/95	80	216	296
	" "	93/94	86	224	310
Custodial staff	(*Lokalvårdare*)	2004	23,5	6,5	30,0
	" "	2002	25,2	3,8	28,9
	" "	2001	26,5	3,0	29,5
	" "	2004	236,2	590,6	826,8
Doctoral research students	(*Forskarstuderande*)	2003	238,5	641,4	879,9
	" "	2002	243,8	625,0	868,9
	" "	2001	188,1	633,2	821,3
	" "	2000	193,6	603,5	797,1
	(*Anst. som Doktorand*)	1999	182,2	563,1	745,3
	" "	1998	167	536	703
	(*Doktorandtjänster*)	1997	149	500	649
	" "	95/96	114	484	598
	" "	94/95	96	432	528
	" "	93/94	87	405	492
Total teachers	(*Summa Lärarpersonal*)	2000	90,6	610,0	700,6
	" "	1999	87,8	652,2	740,0
Teachers	(*Lärare*)	1998	89	660	749
	" "	1997	96	691	787
	" "	95/96	58	632	691
	" "	94/95	51	578	629
	" "	93/94	60	636	696
Other teaching staff	(*Övr. underv. personal*)	2000	114,3	390,0	504,3
	" "	1999	124,3	444,1	568,5
	" "	1998	115	441	556
	" "	1997	111	443	554
	" "	95/96	109	463	573
	" "	94/95	114	448	561
	" "	93/94	125	468	593
Guest / Part-time teacher	(*Gäst/Timlärare*)	2004	1,2	9,2	10,4
	" "	2003	1,5	7,8	9,3
	" "	2002	1,0	5,5	6,5
	" "	2001	2,4	5,2	7,6
	" "	2000	7,4	26,1	33,5
	" "	1999	18,5	61,1	79,7
Junior lecturer	(*Adjunkt*)	2004	40,5	157,6	198,1
	" "	2003	43,6	154,8	198,3
	" "	2002	46,7	164,3	211,0
	" "	2001	40,5	164,4	204,9
Other research & teaching staff		2004	77,1	216,3	293,4
(Annan forskande och underv. personal)		2003	65,8	210,3	276,1
	" "	2002	46,8	191,2	238,0
	" "	2001	34,2	163,9	198,1
Limited-contract teachers	(*Arvodister*)	2004		1,3	1,3

	" "	2003	2,7	4,0	6,7
	" "	2002	3,6	9,0	12,6
	" "	2001	31,2	35,0	66,2
Post-doctoral assistant	(*Forskarassistent*)	2004	5,0	33,5	38,5
	" "	2003	10,0	40,5	50,5
	" "	2002	14,6	36,2	50,8
	" "	2001	21,1	49,6	70,8
Lecturer	(*Lektor*)	2004	30,5	207,0	237,4
	" "	2003	31,4	212,4	243,8
	" "	2002	27,0	218,5	245,5
	" "	2001	20,0	211,4	231,4
Professor	(*Professor*)	2004	17,1	211,8	228,9
	" "	2003	13,9	205,4	219,3
	" "	2002	11,7	199,9	211,6
	" "	2001	12,7	192,1	204,8

Personnel data from Högskoleverket's NU database (Sweden's National Agency for Higher Education)

Swedish Higher Education: Indicators & statistics		Nationally	Jönköping	KTH	Lund	Umeå
Beginners at specific institution of Higher Education GU: Nybörjare vid lärosätet	2004	145353	3757	5649	12270	6655
	2003	143725	4409	5003	11450	6417
	2002	132442	4666	4572	9985	5953
	2001	120868	2384	4172	9124	5784
	2000	118274	2145	3981	8631	5842
First time in Higher Education GU: Första gången i högskoleutbildning	2004	83301	2547	3400	7718	4026
	2003	83319	2853	2916	7316	3912
	2002	78298	2361	2809	6684	3936
	2001	72066	1705	2628	6131	3709
	2000	70043	1557	2504	5649	3896
% beginners achieving first choice GU: Andel nybörjare på förstahandsval (%)	2004	73	69	-	76	73
	2003	76	73	84	80	75
	2002	76	74	83	82	75
	2001	74	73	82	79	75
% remaining after 2 years GU: Kvarvarande år 2 (%)	2004	67	70	78	66	71
	2003	69	70	79	69	72
	2002	68	69	81	68	71
	2001	68	69	78	67	71
Median age, new students GU: Medianålder, högskolenybörjare	2004	22,5	22,3	22,6	21,6	22,3
	2003	22,6	22,6	22,2	21,5	22
	2002	22,4	21,9	21,6	21,4	22
	2001	22,3	22,1	21,5	21,3	22,0
	2000	22,3	22	21,8	21,3	21,8
Percentage male, new students GU: Andel män, högskolenybörjare (%)	2004	43	41	74	46	40
	2003	42	42	74	46	40
	2002	42	45	75	45	41
	2001	42	47	74	45	40
	2000	42	46	72	45	39
% from working class background GU: Andel med arbetarbakgrund (%)	2004	24	29	17	17	26
	2003	24	29	18	16	25
	2002	23	25	16	16	25

	2001	23	25	15	17	25
Working class background compared to index figure GU: Jämförelsetal, arbetarbakgrund	2004	0,72	0,78	0,63	0,52	0,75
	2003	0,73	0,8	0,66	0,52	0,73
	2002	0,70	0,7	0,6	0,5	0,72
	2001	0,69	0,69	0,58	0,53	0,72
Indicator or statistic		**Nationally**	**Jönköping**	**KTH**	**Lund**	**Umeå**
% with foreign background GU: Andel med utländsk bakgrund (%)	2004	16	14	29	15	10
	2003	15	14	28	13	8
	2002	14	12	26	14	8
	2001	13	11	22	13	7
Foreign background compared to index figure GU: Jämförelsetal, utländsk bakgrund	2004	0,98	1	1,3	0,88	1,05
	2003	0,96	1,04	1,28	0,78	0,89
	2002	0,92	0,93	1,25	0,87	0,94
	2001	0,92	0,87	1,09	0,89	0,91
% w Parents w HEduc GU: Andel med högutbildade föräldrar (%)	2004	29	17	40	42	29
	2003	28	21	40	42	29
	2002	29	21	42	43	28
	2001	29	22	41	42	29
Students w Parents w HEduc compared to index figure GU: Jämförelsetal, föräldrars utbildning	2004	1,45	1,16	1,55	1,88	1,49
	2003	1,43	1,34	1,54	1,84	1,5
	2002	1,47	1,37	1,64	1,87	1,48
	2001	1,52	1,46	1,62	1,89	1,54
Number of students, Autumn term GU: Antal studenter (hösttermin)	2004	337415	8098	14195	30520	19286
	2003	340034	8676	14118	30207	18332
	2002	328804	8485	13004	28708	17921
	2001	300800	5683	11888	25814	17275
	2000	284998	5313	11564	24849	17166
% male registrants GU: Andel män av registrerade (%)	2004	40	36	72	46	38
	2003	40	37	72	46	39
	2002	40	37	72	46	38
	2001	40	44	72	46	39
# full time students GU: Antal helårsstudenter (HST)	2004	302562	7052	12367	27970	16744
	2003	299746	7229	12032	27013	16345
	2002	287236	6863	11262	25648	15911
	2001	268061	4922	10573	23643	15739
	2000	256850	4619	10393	23219	15516
# full time successful results GU: Antal helårsprestationer (HPR)	2004	250000	6008	10112	22882	14004
	2003	246369	6038	9955	21640	13782
	2002	234982	5667	9798	20780	13356
	2001	222651	4180	9311	19354	13318
	2000	212891	3819	9082	18977	13087
Successful results ratio % GU: Prestationsgrad (%)	2004	83	85	82	82	84
	2003	82	84	83	80	84
	2002	82	83	87	81	84
	2001	83	85	88	82	85
	2000	83	83	87	82	84
Indicator or statistic		**Nationally**	**Jönköping**	**KTH**	**Lund**	**Umeå**
% courses w even gender balance GU: Kurser med jämn könsfördelning (%)	2004	25	26	17	35	27
	2003	26	24	17	32	29

	2002	25	31	14	35	28
	2001	27	35	16	39	27
% non-trad students GU: Andel icke-traditionella studenter (%)	2004	51	43	42	40	50
	2003	52	46	40	40	49
	2002	52	48	39	41	49
	2001	50	41	36	38	48
% not completing? GU: Andel i återkommande utbildning (%)	2004	25	20	18	20	27
	2003	25	21	18	20	25
	2002	25	20	16	20	25
	2001	24	16	14	19	24
Resitting after graduation GU: Återkommande efter examen (%)	2004	10,4	9,9	5,7	6,8	12,5
	2003	10,6	10,3	5,8	6,4	11,5
	2002	10,6	9,9	4,9	6,7	11,7
	2001	9,9	5,6	3,5	6,3	10,8
% full time students in Humanities, SocSci, Law GU: HSJ, andel Hst (%)	2004	44	44	8	55	43
	2003	45	45	7	56	44
	2002	45	45	6	56	44
	2001	44	52	6	55	44
	2000	45	51	5	55	45
% full time students in Natural Sciences GU: N, andel HST (%)	2004	12	5	22	8	13
	2003	12	5	22	8	13
	2002	13	6	22	8	14
	2001	14	8	25	8	15
	2000	15	10	25	9	16
% full time students in technical studies GU: T, andel HST (%)	2004	18	22	70	20	10
	2003	18	22	72	20	10
	2002	19	22	71	19	11
	2001	19	26	70	20	11
	2000	19	27	70	20	10
% full time students in other programmes GU: Övriga, andel HST (%)	2004	26	29	1	17	34
	2003	25	28	1	16	33
	2002	24	27	-	16	31
	2001	22	14	-	17	30
	2000	22	13	-	17	28
Total # graduates GU: Totalt antal avlagda examina	2004	52343	1695	2027	4050	3215
	2003	47755	1150	1935	3693	3392
	2002	42949	1034	1795	3479	2963
	2001	39675	656	1741	3380	2678
	2000	39960	685	2048	3701	2580
# Magister degrees GU: Antal magisterexamina	2004	10321	230	212	1133	604
	2003	9054	217	154	1081	761
	2002	8284	214	29	1031	692
	2001	7473	167	1	920	642
	2000	6799	155	-	947	578
# MSc degrees GU: Antal civ.ing.examina	2004	4212	-	1169	662	135
	2003	3951	-	1137	631	139
	2002	3861	-	1146	554	135
	2001	3599	-	1161	509	104
	2000	3796	-	1438	516	89
# Bachelor degrees	2004	12501	462	14	664	810

GU: Antal kandidatexamina						
	2003	10982	216	4	579	677
	2002	9713	255	14	664	581
	2001	9003	169	12	645	523
	2000	8450	157	43	731	496
Indicator or statistic		**Nationally**	**Jönköping**	**KTH**	**Lund**	**Umeå**
# receiving first degree GU: Antal förstagångs examinerade	2004	38657	1086	1893	3200	2152
	2003	36423	988	1840	2983	2367
	2002	33923	886	1686	2831	2210
	2001	31757	601	1642	2747	2024
	2000	32202	638	1918	2971	1929
% receiving first degree GU: Andel förstagångs examinerade (%)	2004	74	64	93	79	67
	2003	76	86	95	81	70
	2002	79	86	94	81	75
	2001	80	92	94	81	76
	2000	81	93	94	80	75
Ave length yrs (usually 3 yr course) GU: Examenslängd (antal år)	2004	3,7	3,4	4	4,1	3,6
	2003	3,6	3,4	3,9	4,1	3,6
	2002	3,6	3,4	3,9	4,1	3,6
	2001	3,7	3,5	4,0	4,1	3,6
	2000	3,6	3,5	4,1	4	3,6
Completion rate within 7 yrs GU: Examinerade alt.120 poäng inom 7 år (%)	2004	64	69	66	66	70
	2003	63	69	66	67	68
	2002	63	70	67	67	66
	2001	62	64	67	69	68
Ave credits completed after 3 yrs GU: Genomsnittspoäng efter 3 år	2004	76	78	84	73	78
	2003	76	78	83	73	79
	2002	75	79	80	72	80
	2001	77	88	84	73	82
Incoming exchange & intl. students GU: Antal inresande studenter	2004	11934	609	901	1563	414
	2003	10566	621	775	1459	340
	2002	9515	541	734	1406	326
	2001	8467	404	631	1201	291
	2000	7933	327	562	1117	323
Outgoing exchange & intl. students GU: Antal utresande studenter	2004	6759	492	665	911	259
	2003	6434	398	604	803	240
	2002	5959	345	560	721	243
	2001	5988	304	642	722	358
	2000	6258	297	598	872	324
% who took degree w foreign study GU: Utresande av examinerade (%)	2004	17	45	35	28	12
	2003	18	40	33	27	10
	2002	18	39	33	25	11
	2001	19	51	39	26	18
	2000	19	47	31	29	17
Indicator or statistic		**Nationally**	**Jönköping**	**KTH**	**Lund**	**Umeå**
% continuing to research FU: Övergång till forskarutbildning (%)	2004	7,2	0,9	10,3	10,6	8,5
	2003	7,1	1	11,3	10,3	9,2
	2002	6,9	0,8	12	10,1	9,6
	2001	6,5	0,7	12,1	10,0	9,4
	2000	5,7	0,7	12,8	8,8	8,2

% continuing to research but for certain designated degrees FU: Övergång till forskarutb. vissa examina (%)	2004	12	3	12	15	14
	2003	13	3	13	15	15
	2002	14	3	14	16	16
	2001	15	3	15	16	17
Beginning doctoral researchers FU: Nybörjare i forskarutbildning	2004	2944	5	290	432	193
	2003	3828	7	313	597	248
	2002	3862	18	317	588	237
	2001	3544	11	305	498	222
	2000	3060	1	255	438	161
	1999	3034	11	316	459	145
% of researchers developed within same univ. FU: Rekrytering från egen högskola	2004	45	20	47	53	52
	2003	46	14	49	55	60
	2002	44	50	41	53	46
	2001	43	36	29	57	49
	2000	42	100	45	47	45
	1999	43	27	40	53	51
Active doctoral researchers FU: Aktiva forskarstuderande (ht)	2004	19260	65	1715	3045	1230
	2003	20050	64	1732	3147	1259
	2002	19420	65	1692	3085	1153
	2001	18951	49	1663	3090	1179
	2000	18657	41	1690	3138	1109
	1999	18854	42	1742	3278	1162
Median age of active doctoral researchers FU: Medianålder, aktiva forskarstuderande (ht)	2004	32,9	31,6	31,3	32,9	33,7
	2003	32,8	31,1	31,5	32,8	33,8
	2002	33	30,5	31,5	33,1	33,4
	2001	33,1	29,5	31,2	33,3	33,8
	2000	33,2	30	31,1	33,2	33,9
	1999	33,2	29	30,8	33,3	33,9
Ave activity active doctoral researchers FU: Medelaktivitet, forskarstuderande (ht)	2004	70	64	71	68	70
	2003	71	63	72	69	70
	2002	70	67	71	69	70
	2001	70	64	70	70	66
	2000	70	71	71	70	69
	1999	69	72	70	68	69
Doctoral student FTE FU: Forskarstuderande (heltidsekv.), ht	2004	13519	42	1216	2077	858
	2003	14148	40	1244	2167	881
	2002	13619	43	1200	2124	811
	2001	13196	31	1166	2151	782
	2000	13069	29	1196	2182	764
	1999	13084	30	1228	2237	807
# employed as doctoral students, FTE FU: Antal anställda som doktorand, heltidsekv.	2004	7396	37	716	1211	513
	2003	7616	35	765	1231	523
	2002	7176	39	723	1169	526
	2001	6720	29	693	1167	454
	2000	6561	28	675	1162	457
	1999	6358	28	667	1139	496
Indicator or statistic		**Nationally**	**Jönköping**	**KTH**	**Lund**	**Umeå**
% employed as researchers FTE FU: Andel doktorand anställningar (heltidsekv.), %	2004	55	90	59	58	60
	2003	54	87	61	57	59
	2002	53	89	60	55	65

	2001	51	94	59	54	58
	2000	50	95	56	53	60
	1999	49	91	54	51	62
Ratio doctoral students FTE to doctoral degrees FU: Forskarstuderande (heltidsekv.) / Dr.examina	2004	5	8	5	5	5
	2003	5	20	6	4	6
	2002	6	9	7	5	5
	2001	5	8	6	5	5
	2000	6	-	7	6	5
	1999	6	8	8	6	7
# doctoral degrees FU: Antal doktorsexamina	2004	2741	5	223	458	161
	2003	2701	2	223	483	150
	2002	2476	5	175	458	148
	2001	2413	4	202	399	162
	2000	2176	-	171	368	156
	1999	2148	4	163	381	117
# of licentiate degrees FU: Antal licentiatexamina	2004	1096	-	195	89	27
	2003	1041	-	163	127	22
	2002	1024	1	156	109	24
	2001	1045	-	176	112	28
	2000	1009	-	200	118	31
	1999	968	2	165	131	32
# employed FTE PE: Antal anställda (heltidsekv.)	2004	43207	580	2081	4768	3018
	2003	43861	588	2128	4796	3074
	2002	42575	570	2133	4647	2956
	2001	41067	385	2055	4447	2871
% teachers PE: Andel lärare (%)	2004	56	57	56	53	58
	2003	55	57	56	53	57
	2002	55	54	55	50	57
	2001	53	48	53	51	56
# teachers FTE PE: Antal lärare (heltidsekv.)	2004	24080	330	1157	2505	1738
	2003	24227	336	1189	2529	1740
	2002	23327	308	1163	2321	1684
	2001	21878	185	1087	2251	1607
% women teachers PE: Andel kvinnor (%)	2004	40	49	18	32	43
	2003	39	49	18	31	43
	2002	38	45	16	30	43
	2001	37	32	15	29	42
FT students per teacher PE: Helårsstudenter per lärare	2004	12,6	21,4	10,7	11,2	9,6
	2003	12,4	21,5	10,1	10,7	9,4
	2002	12,3	22,3	9,7	11,1	9,4
	2001	12,3	26,5	9,7	10,5	9,8
Teachers with doctorate FTE PE: Disputerade lärare (heltidsekv)	2004	12338	100	660	1594	836
	2003	11957	104	645	1557	810
	2002	11205	97	608	1449	761
	2001	10590	60	586	1390	715
% of teachers with doctorate PE: Andel disputerade lärare (%)	2004	51	30	57	64	48
	2003	49	31	54	62	47
	2002	48	32	52	62	45
	2001	48	32	54	62	45

# professors FTE PE: Antal professorer (heltidsekv.)	2004	3841	32	229	581	237
	2003	3659	29	219	558	232
	2002	3503	27	212	540	226
	2001	3268	21	205	491	217
% professors PE: Andel professorer (av lärare, %)	2004	16	10	20	23	14
	2003	15	9	18	22	13
	2002	15	9	18	23	13
	2001	15	11	19	22	13
Indicator or statistic		**Nationally**	**Jönköping**	**KTH**	**Lund**	**Umeå**
Turnover (in millions of kronor) EK: Omslutning (miljoner kronor)	2004	44725	560	2738	5043	2874
	2003	43701	537	2741	4957	2749
	2002	41468	483	2702	4682	2601
	2001	38175	327	2414	4433	2386
	2000	36522	308	2414	4199	2249
Office costs as % of turnover EK: Andel lokalkostnad av omslutning (%)	2004	14,4	14,0	19,4	13,1	9,8
	2003	14,2	14,7	18,4	13,3	10,4
	2002	14,2	16,3	18,9	12,6	10,4
	2001	14,1	19,8	17,3	12,7	10,1
	2000	13,8	18,1	17,3	11,9	10,6
Library as % of total costs EK: Andel bibliotekskostnad av omslutning (%)	2003	2,7	2,6		2	2,2
	2002	2,3			2	2,2
	2001	2,7	-	3,0	2,2	2,3
	2000	-	-	-	-	-
Undergraduate education as % total costs EK: Andel grundutbildning av totalkostnad (%)	2004	46,3	74,9	35,6	34,4	45,8
	2003	46,4	77,5	35,1	35,4	45,3
	2002	45,3	79,6	33,2	34,8	44
	2001	44,9	76,9	33,6	33,9	42,3
	2000	44,1	73,2	33,6	31,5	42,3
% research education EK: Andel forskning/forskarutbildning (%)	2004	53,5	25,1	64,4	65,6	54,2
	2003	53,3	22,5	64,9	64,6	54,7
	2002	54,2	20,4	66,8	65,2	56
	2001	54,3	23,1	66,4	66,1	54,9
	2000	53,7	26,8	66,4	64,6	55
% external financing EK: Andel extern finansiering totalt (%)	2004	35,2	28,1	44,6	38,3	31,9
	2003	35,3	25,5	45,5	40,4	31
	2002	35,5	20,9	46,5	40,8	30,2
	2001	39,2	26,2	46,0	42,1	32,2
	2000	40,4	27,6	46	42,7	31,2
% income from govt budget EK: Andel (statliga) anslag (%)	2004	64,8	71,9	55,4	61,7	68,1
	2003	64,7	74,5	54,5	59,6	69
	2002	64,5	79,1	53,5	59,2	69,8
	2001	60,8	73,8	54,0	57,9	67,8
	2000	59,6	72,4	54	57,3	68,8
% research grants EK: Andel forskningsanslag (%)	2004	37,6	9,3	42,7	48,5	44,1
	2003	37	9	43,5	48	44,6
	2002	37,8	8,5	44,8	48,9	45,6
	2001	41,4	10,9	46,2	53,2	47,0
	2000	42,3	10,1	46,2	53,7	48,9
Indicator or statistic		**Nationally**	**Jönköping**	**KTH**	**Lund**	**Umeå**

Grants for research & research educ per doctorate granted as % of total research funds EK: Anslag forskning/forskarutb. per Dr. examina	2004	3,9	-	2,9	3,1	5,2
	2003	3,9	-	2,9	2,9	5,6
	2002	4,1	-	3,6	3,0	5,5
	2001	4,0	-	3,0	3,4	4,8
	2000	4,2	-	3,5	3,5	4,9
	1999	4,0	-	3,2	3,4	5,7
% external commissioned education EK: Andel uppdragsutbildning (%)	2004	5,4	5,1	1,2	2,8	10,8
	2003	5,3	5,6	2,1	2,5	10,4
% external research EK: Andel uppdragsforskning (%)	2004	7,0	31,5	5,7	4,2	9,1
	2003	6,2	4,2	5,2	3,1	8,1
Income from research EK: Intäkter, forskning (milj. kr.)	2004	23464	144	1758	3116	1521
	2003	23072	121	1772	3175	1484
	2002	22195	94	1764	3082	1423
	2001	20390	75	1591	2923	1307
	2000	19479	82	1591	2667	1252
Ratio external financing EK: Andel extern finansiering, FFU (%)	2004	53,5	71,7	63,0	53,3	44,1
	2003	54,8	69,8	63,4	56,1	43,6
	2002	54,6	65,5	63,9	55,7	42,9
	2001	53,2	64,7	62,3	53,5	40,5
	2000	52,6	71,9	62,3	51,9	38,8
% financing from Research Councils EK: Finansiering från forskningsråd (%)	2004	16,1	2,1	15,5	20,6	17,8
	2003	15	4,1	15,6	19,3	14,6
	2002	13,5	1,8	14,6	17,2	14,3
	2001	13,2	-	16,3	17,2	16,5
	2000	14,9	-	16,3	20,9	19
Indicator or statistic		**Nationally**	**Jönköping**	**KTH**	**Lund**	**Umeå**

http://nu.hsv.se/NUController?event=NYCKELTAL_RESULTAT

Swedish Higher Education: Key nationwide data for comparisons

all 2004		% of teachers with doctorate -- PE: Andel disputerade lärare (%)						
		% income from govt budget -- EK: Andel (statliga) anslag (%)						↓ ↓
		% financing from Research Councils -- EK: Finansiering från forskningsråd (%)				↓ ↓	↓ ↓	↓ ↓
		Ratio of external financing -- EK: Andel extern finansiering totalt (%)			↓ ↓	↓ ↓	↓ ↓	↓ ↓
		Full time students per teacher -- PE: Helårsstudenter per lärare		↓ ↓	↓ ↓	↓ ↓	↓ ↓	↓ ↓
		Successful results ratio -- GU: Prestationsgrad (%)		↓ ↓	↓ ↓	↓ ↓	↓ ↓	↓ ↓
		# of Fulltime students -- GU: Antal helårsstudenter (HST)	↓ ↓	↓ ↓	↓ ↓	↓ ↓	↓ ↓	↓ ↓
National totals / Riket		**302562**	**83**	**12.6**	**35.2**	16.1	64,8	51
Beckmans designhögskola		119	100	12.3				-
Blekinge internationella hälsohögskola								31
Blekinge tekniska högskola		3120	75	16.3	32.0	2.9	68,0	
Chalmers tekniska högskola		8459	87	9.6	51.3	14.7	48,7	62
Danshögskolan		139	87	6	14.2	54.6	85,8	7
Dramatiska institutet		151	99	6.3	10.0	96.5	90,0	2
Övr. enskilda anordn. psykoterapeututb.		196	100	9.5				16
Ericastiftelsen		33	100	5.4				14
Ersta Sköndal högskola		774	89	10.9				32
Gymnastik- och idrottshögskolan		515	88	8.8	30.1		69,9	36
Gammelkroppa Skogsskola		19	100	3.2				-
Göteborgs universitet		26066	82	11.8	33.4	18.3	66,6	58
Högskolan i Borås		5329	89	17.2	16.0	2.7	84,0	26
Högskolan Dalarna		5218	84	15.4	16.9	1.3	83,1	33
Högskolan på Gotland		1973	67	22	32.0	12.6	68,0	29
Högskolan i Halmstad		5394	85	22.9	16.6		83,4	39
Hälsohögskolan i Jönköping								
Handelshögskolan i Stockholm		1321	91	15	77.2	5.5	22,8	76
Högskolan i Gävle		6311	80	15.5	15.7	2.7	84,3	35
Högskolan i Jönköping	***	7052	85	21.4	28.1	2.1	29	30
Högskolan i Kalmar		6394	86	17.5	25.4	11.2	74,6	29
Högskolan Kristianstad		5622	85	17.5	11.6	27.2	88,4	29
Högskolan i Skövde		4307	80	22.9	11.7	3.3	88,3	27
Högskolan i Trollhättan/Uddevalla		4442	84	17.5	17.1		82,9	29
Hälsohögskolan Väst i Vänersborg								
Ingesunds Musikhögskola								
Johannelunds Teologiska högskola		74	96	8				48
Karlstads universitet		8863	81	14.7	22.0	7.3	78,0	32
Konstfack		623	90	8.8	7.8	89.7	92,2	3
Karolinska institutet		5850	90	4.2	51.0	14.5	49,0	65
Kungl. Konsthögskolan		216	100	7.6	7.9	71.3	92,1	4
Kungl. Musikhögskolan i Stockholm		556	101	6.3	11.9		88,1	6
Kungl. Tekniska högskolan	***	12367	82	10.7	44.6	15.5	42	57
Lärarhögskolan i Stockholm		6601	90	20.1	24.9	24.7	75,1	24
Linköpings universitet		18227	83	13.7	31.8	16.7	68,2	58
Luleå tekniska universitet		8479	84	13.7	32.3	4.6	67,7	42
Lunds universitet	***	27970	82	11.2	38.3	20.6	35	64
Malmö högskola		10733	87	18.5	20.4	20.7	79,6	37
Mälardalens högskola		8861	83	17.8	17.7	5.4	82,3	33
Mittuniversitetet		8124	78	17.2	24.8	1.3	75,2	35
Operahögskolan i Stockholm		74	100	6.2	11.8		88,2	-
Röda Korsets högskola		420	102	13.7				28
Södertörns Högskola		7056	76	24.7	42.4	5.6	57,6	56
Sophiahemmet högskola		316	101	10.6				29
Sveriges lantbruksuniversitet		3340	92	2.9	45.6	4.0	54,4	64
Stockholms Musikpedagogiska Institut		69	96	7.3				8
Stockholms universitet		24204	75	14.3	33.1	27.0	66,9	59
Hälsohögskolan Väst, Skövde								
Teaterhögskolan i Stockholm		69	100	3.9	1.7		98,3	0
Teologiska Högskolan, Stockholm		217	81	16.4				71
Umeå universitet	***	16744	84	9.6	31.9	17.8	42	48
Uppsala universitet		21337	81	10.3	38.5	23.3	61,5	64
Vårdhögskolan Boden								
Vårdhögskolan Falun								
Vårdhögskolan Gävle								
Vårdhögskolan i Borås								
Vårdhögskolan i Växjö								
Växjö universitet		8336	82	19.7	22.8	13.4	77,2	35
Örebro teologiska högskola		154	73	13.7				40
Örebro universitet		9731	84	19.3	18.1	13.8	81,9	42

*** four Swedish EUEREK cases *Reported totals do not match: subtotals add to 302,565; 302,562 reported.*
http://nu.hsv.se/NyckeltalController?event=NYCKELTAL_URVAL

KTH in figures from the *KTH Annual Report 2004*, via http://www.kth.se/eng/about/figures.html

Undergraduate studies

- Architects' programme
- 14 Master of Science programmes
- 9 Bachelor of Science programmes
- 36 Master programmes
- Vocational higher education, advanced study programmes, continuing education and extension courses, Technical Preparatory Year

New admissions

- 2,995 new students; 24% women.

Student performance

- 12,642 full-time students; equalling 10,118 full-year performance equivalents.

Graduations

- 1,346 students graduated as Architect or MSc; 33% women.
- 451 students graduated as BSc (programmes totalling 120 credits = 3 years or 80 credits = 2 years); 31% women.

Postgraduate/Doctoral studies & research

- 1,609 active postgraduate & doctoral students (>=50% activity, or more); 28% women

Graduations

- 195 licentiate degrees – 25% women
- 224 doctor's degrees – 22% women

Centres of Excellence

- Nine national competence centres in engineering financed by government agencies, universities and companies – one third each
- 30 other centres of excellence

Finances

KTH is a public university, mainly funded by government grants.

- Annual turnover € 320 million of which:

University allocations

- € 98 million undergraduate education
- € 73 million research/doctoral studies

External financing

- € 20 million from the Swedish Research Council
- € 61 million from government agencies
- € 13 million from foundations etc.
- € 39 million from private funds including financial revenues

Staff

- 3,002 employees, of which:
- 2,014 men, 988 women
- 238 professors, 242 associate professors

Premises

- 250,000 square metres

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http://www.kth.se/styrdokument/utvecklingsplan/2004/developingplan04.pdf (English)
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Attachment A:

KTH. (2004b) *KTH – today and tomorrow: KTH crosses borders*. (*KTH Development Plan.* partial English-language translation of *Idag och imorgon: Utvecklingsplan 2004-2007*), Stockholm: Kungliga Tekniska högskolan (Royal Institute of Technology); available online at:
http://www.kth.se/styrdokument/utvecklingsplan/2004/developingplan04.pdf (English)
http://www.kth.se/styrdokument/utvecklingsplan/2004/utvecklingsplan04.pdf (Swedish)

For our English speaking readers we hereby give a translation of the strategy part of our developing plan including descriptions of our focus areas

KTH – today and tomorrow

KTH crosses borders

The national importance of KTH continues

KTH's importance to Sweden's industrial development remains as great as ever. Through its research activities, new knowledge is created and students are rewarded with significant insights into scientific endeavour, technical sciences and engineering expertise. In addition, KTH develops students' ability to apply their knowledge for the benefit of society. A degree from KTH must be perceived as the key to a future career and lifestyle, and provide a guarantee for future employers as concerns the depth and breadth of the individual's knowledge.

A critical examination of societal development and events is included in KTH's role, as well as creating a place of learning in which people of different backgrounds and experience work on their common task of managing, renewing and transferring knowledge. Diversity of preconditions and experience enriches all parts of KTH operations and must be used to its advantage.

The European perspective must be reflected in all KTH operations

Students already regard Europe as their labour market; it will soon be as natural to move to England, Italy or Belgium as it is to move within Sweden. This trend is also clearly reflected in the steadily increasing stream of overseas students applying to KTH courses. Globalisation of technical research and education injects a dynamic into KTH's development which cannot be obtained from any other source.

Only as a technical university in Europe can KTH's position be retained and strengthened. Developing KTH to one of the leading European technical universities will be the most important task for the next few years and sets the tone for KTH's vision as formulated in 2003.

The participation and influence of the rest of the world on KTH's research is becoming increasingly evident

Recent research – especially at the engineering and natural sciences faculties – is, to a great extent, aimed at areas with clear links to society and industry. Consequently, clients from outside the university in both the public and private sectors contribute problem descriptions, participate in decision making concerning special projects, and often also fund, research. KTH's research is

increasingly financed – currently two thirds – by funding outside direct government allocations for research and doctoral studies. This shift can be expected to accelerate due to increased EU resources and a political will to distribute a greater part of government funding in a competitive situation.

Make engineering sciences visible as separate fields of study

Certain of the financiers' recent tendency to ignore engineering as a science in itself is a worrying signal. It is a continuous struggle to convince stakeholders that engineering sciences are not applied natural sciences but a field of their own whose core is the creation of new technology through the synthesis of knowledge from various other disciplines. This creative process often results in new technical systems for industrial and social activities. It is exactly this expertise within industry that has given Sweden its prominent position as an industrial nation.

Technology consists of activities which, with no given answers, result in innovatations. Engineering and other sciences provide the preconditions.

Basic research within engineering sciences is a primary precondition for development, not only within the natural sciences but also, to an increasing degree, within social sciences, arts and medicine. This new interaction is the foundation of strong basic research across the entire scientific spectrum.

New engineering platforms

Vital elements include two change processes, currently underway, which are staking out the path of higher technical education and research: one process which is driven by industrial growth areas such as IT, biotechnology and nanotechnology, and a second process which means that all of us, irrespective of the area we work in, must use a common technology and methodology base. Examples of the latter can be observed in the use of simulation and large scale technical calculations, also the ability to use advanced mathematics and dataology in the development of new cars, boats and planes and also for traditionally non-technical areas such as health and medical care. These areas actually often demonstrate a great need for the practical approach to problem situations represented by scientific method. Another example is the ability to mix, for example, automatic engineering and signal processing with neurology and behavioural sciences in order to create the future interaction between humans and computers needed to design production systems.

Engineering methods and knowledge are currently in use in totally new, and until recently totally unexpected, contexts within all areas of social and industrial development.

Shifts in technology occur at increasingly short intervals and demand more flexibility

The profiles of these scientific fields are changing rapidly. There are many worries concerning the financing situation, not least for the more applied subjects. Part of this latter problem can be related to the fact that the period of time between generations of technology within industry have become progressively shorter which makes greater demands on flexibility and the ability to adapt

research areas, tools and methods. The time is past when methodological and knowledge development were primarily related to individual industries. Within undergraduate education the most important element is to provide students with training in the management of general methods and tools as well as an understanding of the industrial applications that demonstrate how these methods can be used. Education must also provide opportunities for continued development. Consequently changes to the learning process at KTH are necessary to include more problem and project based elements and greater individual responsibility for students in the higher classes, as well as a focus on general knowledge that is viable over time.

Stronger emphasis on basic knowledge and methods facilitates working methods based on synthesis and design

In addition to providing students with a foundation for continuous professional development, basic educational knowledge should promote industrial creativity in that it leads to free thought patterns for problem solving, especially when encountering new situations. Stronger emphasis on basic knowledge and methods facilitates working methods based on synthesis and design and improves the individual' chances of acquiring new knowledge during the course of a long working life.

The highest priority for KTH is to operate a technical university offering qualified educational courses and research. KTH must continuously reform in order to ensure that activities are relevant to new industrial and scientific growth areas. In order to avoid a never-ending struggle concerning new educational titling it is essential that the engineering and natural sciences core are equipped with a greater concentration of generic subjects, which allows KTH to cover a broad spectrum while maintaining in-depth studies and research.

Networks are the key

Networking between KTH's bearers of generic knowledge and general engineering scientific methods and the more application-oriented specialists will form one vital element of more flexible research cooperation within KTH and in association with external stakeholders such as research councils, foundations, sector agencies, industry and other parts of society.

Comprehensive knowledge of the subject is the basis of successful cooperation

In addition to the strong research environments already in existence, KTH needs to develop its competence within a number of thematic areas. Fruitful, cross-border cooperation requires access to the highest specialist competence within cooperating disciplines. KTH offers, through its rich access to leading edge competence within technology and natural sciences, extensive opportunities for cooperation with other scientific fields. Such cooperation requires a thorough knowledge of the science and strengthens the focus on expertise within it.

Planning is a synthesis of many different fields of knowledge

The development of the new role played by technology is most obvious within the construction and infrastructure field in the form of many, radically changed, educational concepts in relationship to the more classical programmes. Students are still provided with access to knowledge on technical systems, mathematics and physics but these are used based on a management, business or economics perspective. Systems are not only perceived as technical but also to a greater degree as economic, legal and social scientific. This type of knowledge has, more recently, been developed into its own science and this is the type of activity that will be developed at KTH. It is necessary to establish cooperation between these areas and the general engineering subjects as a complement to KTH's traditional educational courses.

KTH's courses and research are developing towards a deeper technical knowledge which will provide its engineers and doctoral students with the opportunity of leading technical and social development.

KTH's most important contribution to social development is the students it educates

Knowledge that is managed and refined within KTH contributes, in various ways, to social and industrial development. The most important contribution in this context is, and always will be, KTH students. Other contributions include the new companies which are continuously being established by or with KTH researchers and new, extensive cooperation developed with the industrial research institutes on KTH campus who can be expected to take over parts of KTH's current operations within the areas closer to practical applications.

Critical reflection on the content of their knowledge must be exercised by all KTH students

Promoting a critical approach in students' minds is a given for a research university. Political ambitions concerning higher education in Sweden have, during the last few years, been strongly focused on quantity - universities have degree award targets to fulfil and students must perform at sufficient speed to qualify for student loans. Critical reflection on knowledge is essential in order to avoid the risk of trivialising the contents of that knowledge.

KTH aspires to the highest possible quality of education; this quality lies in subject and method expertise as well as in a critical application of the knowledge gained.

Knowledge of the future

Needs for increased research resources and a new approach to research

Renewal of engineering and technical research at KTH, and in the rest of Sweden, has been affected by the situation of research financing during the last few years. Focus and priorities on scientific and industrial growth areas have moved into the spotlight while the breadth of the research spectrum has narrowed.

As a consequence, preconditions for research in other important industrial sectors have also deteriorated dramatically. One example is research into urban studies. There is a well-documented need for research and funding in both the private and the public sector actor, which has lead to research only being able to solve small-scale, short-term problems. In order to be able to retain research within this sector, KTH has to promote more technical scientific research in these areas and then ensure that this is utilised for qualitative knowledge gain. Only though integration of aspects such as basic systems, materials and environmental research can the scarce resources available provide this research with the necessary leverage.

Another area in which financing from public sources has decreased radically over the course of many years is mechanical engineering. This economically vital area includes all product development and plays a significant role for both export and employment opportunities. Less research produces fewer PhDs students, and consequently a future shortfall in competence.

KTH's investments in biotechnology …

Biotechnology has, during the last few years, moved into centre stage, a status previously occupied by IT, as the most important growth area for science and industry. This development can be explained by the fact that biotechnology is less sensitive to the prevailing economic situation due to the subject's clear links with basic natural sciences and through its strong industrial connections to health and medical care. These sectors are growing rapidly and are dependent on technical and medical developments both to cure illnesses and to operate larger-scale care activities. It has also become clear that the coordination of medicine and technology is essential for the development of this field. In the long term there will probably a merging of professional roles within health care and technology. Technical biological sciences provide the opportunity for considerable inputs within health care, through material and apparatus as well as through well-established scientific methodology that emphasises models, simulations and visualisation.

In the interplay between technology and medicine, it is clear that one of technology's major tasks is to create new platforms for successful medical research

… and information technology continue

KTH's research within information technology continues with, generally speaking, unchanged vigour, however focus has shifted towards the softer side – services which information technology can offer human beings and society. Nano-technology, which has been developed from physical, chemical and materials scientific research, has found a new context within areas such as micro-systems technology, production technology and medical technology, where the physical size of many traditional technical objects has been decreased by several numbers. Information technology also provides the preconditions for the development of many other areas.

Subjects complementary to engineering have expanded KTH's research map

Through successive changes to technical education and research, KTH has identified an increasing number of cooperation projects between researchers in subject areas some way away from what has traditionally been considered to be engineering. An expansion of KTH's research map has occurred through these subjects which complement engineering. They originally occurred at KTH as courses components of the various educational programmes in order to provide future engineers with additional profiles. Now they form their own, strong, research environments at KTH. Research within the various areas of industrial economics is currently one of KTH's strongest environments, research within philosophy aimed at technological sciences employs more than twenty PhD students and there will soon be research at the new Banking and Financial Centre. In the production area, cross-border research is underway in which knowledge from technical mechanics, materials technology, information technology, economics, logistics, psychology and occupational sciences is integrated into pure production technology research.

KTH is, and will continue to be, a technical university. However it will be a technical university that, in its research, clearly integrates knowledge from other scientific areas with engineering in order to create new, strong research environments including subjects such as medicine, social sciences, economics and the arts.

Matrix organisation for both education and research

Developments in research can, in some way, be said to have followed earlier developments within education as KTH is currently using broad, cross border programmes. Matrix organisational forms are a given within education as departments are responsible for courses in their subjects while those responsible for the programmes ensure that they provide an education consisting of both detailed knowledge and relevant information. In research, new centres create – in the same fashion – broader research areas crossing discipline and subject borders with the departments on one axis and KTH's specialist centres on the other. Centres also offer opportunities for close cooperation with industry where industry's problem-stating ability contributes a further dimension to university research.

Development of new knowledge occurs in the meetings between researchers from different disciplines who contribute their knowledge and communicate with the help of generally applicable scientific methods.

The engineers of the future

Today's engineers play many different roles

Today, technology moves through practically the entire society, which is clearly reflected in the development of KTH's education for new, industrial and scientific growth areas and through the dynamic development of the classical engineering programmes. The engineers of the future will once again assume the heroic role assigned to them during the industrial development era of the 1950s and 60s.

……however they are always based on knowledge of technology

Many engineers manage larger or smaller scale projects while others work as executive engineers and specialists. The job of executive engineer requires a great deal of independence but also an ability to work in groups with other engineers and with individuals from other backgrounds. Executive engineers possess, through their broad technical and scientific competence, the ability to understand the contributions of their colleagues. In their future, it will be necessary to apply an even more developed ability to, independently and critically, assess how technical development affects companies or societies.

KTH engineers with detailed engineering expertise are essential to develop the technology of the future within industry and society.

KTH should educate generalists rather than narrow specialists

KTH offers educational courses with broadly based titles, general in nature, in order to provide engineers with the preconditions for working within dynamic technical development. In this manner repeated re-christening of courses to meet new fashionable demands will be avoided. This argument does mean a reinforcement of the view that KTH educates generalists rather than narrow specialists. This does not concern knowing a little about as much as possible, this concerns the acquisition of extensive, scientific and methodological competence in combination with an ability to cooperate with other competences. As technical systems increase their direct effect on human beings, it becomes increasingly necessary to provide students with increased knowledge of the interaction between technology and humans so that they will be able to design a technical environment adapted to the needs and circumstances of human beings.

Consensus requires that the general principles introduced in the basic part of the course must be studied in more detail in the later part. This engineering – technology and natural science – approach should be utilised as a guide throughout all courses.

It is also essential to offer an education which provides the preconditions for working in management – project or company. In addition to the "heavy" courses within industrial economics and urban studies, continuous and further educational courses provided by the KTH Executive School, for example, have attracted many engineers active in their professions. These courses have also elicited a positive response from industrial stakeholders and have contributed to an increasing number of engineers competing for top management positions.

Needs for continuous further training must be met

Strategic planning should also be applied to education undertaken later in life. This is an increasingly important element aimed at retaining and developing the depth of the engineering sciences and increasing companies' ability to renew and develop their products. One of the obstacles to this process is that when times are good, companies do not allow their employees to participate in educational inputs and when times are bad there are not sufficient resources.

Consequently benefits to the individual, the company and society are blended in a totally different mix than that relevant to undergraduate courses where society has shouldered the responsibility of putting the relevant resources at the disposal of KTH. A more clearly defined undertaking of responsibility by the state for these further educational inputs as well would mean an increase of competence nationally and would strengthen Sweden's position as an industrial nation.

KTH should intensify the marketing of its technology and engineering range of courses within and for industrial growth areas, as this range of courses has, basically, the same importance for working engineers as it does for undergraduate students at KTH. One necessary precondition is, of course, a good level of basic knowledge

KTH must provide different forms of education of relevance to technical development for individuals in different phases of their working lives.

Learning through research

Essential to prioritise research-oriented elements of KTH courses

KTH's continued development as a global research university and an attractive university for international students can only occur if KTH can offer internationally well-known, recognised courses. In order to educate the people who will be running future European industry and technical developments – in competition with, primarily, USA and Southeast Asia – clear prioritisation of the later, research-oriented part of the Masters of Engineering courses, of new masters programmes and of doctoral studies must be made. Investment in separate masters courses within the European network is one way to attract students in a European, and also global, perspective. Cooperation with others is essential in this situation, not least within areas where KTH is unable to offer a full range of courses.

Teaching in English

The internationalisation of education will therefore continue and English should be the dominant medium of education in the later stages of the masters of engineering programmes and the international masters programmes.

European harmonisation

The role of eminent European university emphasises the need for internationally recognisable and exchangeable educational courses. Considerable developments have occurred within Europe concerning this issue. Governments and Ministers of Education in both new and old member states have united to search for the harmonisation of higher education in Europe. It is unclear how rapidly and deeply such developments will occur in Sweden. KTH is, however, well prepared for these changes.

Quality assessments and accreditation will make KTH's name

For students and future employers, and for KTH operations, clarity of content and form of education is essential. This is also a precondition for high quality education. All courses will be exposed to tougher quality assessments. National quality inspections, often implemented by Swedish authorities, will be complemented by assessments from independent accreditation institutes. The results of these assessments will be extremely significant for how KTH will be able to attract first-class students and teachers in the future and gain recognition from employers and other stakeholders.

In a global educational system, a university's reputation will, in many ways, be more important than the degrees it awards.

Continued prioritisation of doctoral studies vital for KTH and Sweden

The continued prioritisation of research, and not least doctoral studies, is also an important objective for KTH. KTH is already the premier university in Sweden as concerns awarding doctoral and licentiate degrees and is also among the most eminent in Europe. However, unless new resources are allocated there is a risk that the number of doctoral students will, in the very near future, stagnate or decrease.

KTH regards the development of the research-oriented parts of courses as one of its most important tasks in the next few years. In order to achieve this, using the contents of the traditional courses as a support structure, streamlining and coordination of the entire range of courses offered is necessary. This concerns extensive coordination at course level as well as more efficient utilisation of staff, premises and other resources. The key to this solution is regarding all a KTH operations as part of a whole for which common values form the foundation. In an increasingly diversified range of courses it is essential that the connections and differences between the various alternatives are clear to both students and employees.

In the future, KTH's courses must be more connected to strong research environments. Such connections are a precondition for the relevance of such courses and consequently their power to attract new students. The structure of KTH's engineering courses must provide students with maximum choice and encourage the simplest possible in-house mobility.

The university of the future

With tradition into the future

In spite of all the changes in its surroundings, KTH stands strongly in its academic tradition stretching back several hundred years, a tradition of knowledge management, refining and communicating, making serious demands for a clear vision, and belief in its activities and their importance for social development. International, high-quality operations must be able to function in many different contexts, over national, scientific and traditional borders. The vision as it was formulated in 2003 states:

”KTH will stand for extensive competence within the engineering sciences and thereby promote education, research and development that crosses borders.”

The research of the future

Specialisation and cross border research will be prioritised

Disciplinary balance and crossing of borders as concerns research will be important in the years to come.

The approach to be applied to single subject research is that it must be developed within KTH departments. Scientific quality will therefore become decisive as to which research is to be supported. KTH should also, to a limited extent, build up its research within other areas outside the technical sciences. These areas must show clear connections to the technical systems KTH researches into and provides education on.

Half of KTH's research budget is currently taken up by applied research at institutes on its campuses. Improved interaction could bring increased relevance for undergraduate and post-graduate education and create space to prioritise the basic engineering sciences.

If KTH is to stand for engineering research which will benefit the entire sector, a special focus on KTH's own activities and systematic cooperation with industrial research institutes, among others, must be developed.

The interchange between single subject and multi-disciplinary research becomes increasingly natural

Technical research and development has always been multi-disciplinary, irrespective of whether it was called curiosity-driven, strategic, applied or product development. During the decades it has taken for the engineering sciences to be accepted as separate disciplines, areas such as materials technology have been transformed into materials science, construction technology into urban planning and environmental technology into environmental science. Today there is a natural interchange between single and multi-disciplinary research, primarily dependent on the fact that the natural sciences, and to an increasing degree the other areas of science, are so often technology driven and research is carried out based on new technical platforms and industrial growth areas. Biotechnology, information technology and nano and micro-technology are successful examples of how the products of interaction between engineering sciences and medical and scientific research can be utilised across a broad spectrum of industrial applications.

The difference between then and now is the dramatically increased breadth of cross-disciplinary cooperation and that requirements for scientific quality make no distinction between single subject and multi-disciplinary science. Research financiers in USA and Europe have understood this and stimulate developments by supporting joint scientific projects between industry, society and universities as well as in the major scientific networks.

KTH must develop forms to carry out extended cooperation across traditional subject boundaries; forms must be liberated from an inflexible organisational structures in order to meet new needs.

New focus areas

KTH's research centres complement institutional research

In the last ten years a large number of research centres have been established at the various technical universities. These complement departmental research by working across established boundaries. These developments have been supported by industry and research institutions who have been extremely interested in participating in university research, either as a commissioner or with their own research competence. These research centres, however, almost always assume the character of large-scale projects and are not intended to support developments across broader areas.

A number of multi-disciplinary meta-centres should be established

KTH is currently working to develop a number of multi-disciplinary meta-centres aimed at new areas of scientific, industrial and social relevance. These meta-centres, or networks, within research will serve as the equivalent of KTH's current programmes within engineering education. The selection of the meta-centres must be a dynamic process and provide a future orientation to a greater degree than the more practical, individual subject research centres. The guiding principles will be a good combination of scientific, industrial and social relevance.

The most important task of these meta-centres is to act as a focus area, in which problem solving can occur without a clumsy, organisational superstructure. In some way they can be regarded as stakeholders in their common development within interesting areas.

Profile areas

Below are descriptions of a number of research areas of vital importance to KTH's development into an international, technical research university; these may also be regarded as broad, multi-disciplinary meta-centres.

Information Technology

Few European universities are able to show the level of excellence represented by KTH as concerns the entire spectrum of IT activities. The immense importance of this field for all engineering sciences means it has a given place in all courses and in all research at KTH. Applied IT operations are currently everywhere at KTH, while specific research and courses are concentrated at several departments.

Currently, the IT area also represents a link to, and a precondition of, development within other scientific areas. IT research at KTH's campus on Valhallavägen has two major emphases. KTH is prominent in the development IT as an infrastructure for human beings' interaction with computers. This is achieved through research concerning various interfaces, as well as into how individuals and organisations meet IT in their work, their leisure time and their everyday activities – the human aspect of IT use.

KTH is also a leading institution as far as basic datalogical research with applications in areas such as large-scale calculations, database management and bioinformatics are concerned. All these areas provide good preconditions for both subject specific and cross border research.

Research at the IT University in Kista covers the entire spectrum of the computer and telecommunications area, from new materials, new components and electronic circuits, via systems' technical infrastructure to the services offered by these systems to future users. Applications are mainly to be found within wireless communication systems and communications networks, in which industrial cooperation and participation in EU's framework programmes form dominant elements. KTH is also responsible for important engineering science research, primarily within signal processing and network research, based on automatic engineering theory.

IT use is increasing rapidly within all areas including the engineering and vehicle industries. There is also a radical rise in its use within the infrastructure of society and trade, learning and banking operations. Consequently the IT departments' fields of operations are continuously expanding and cooperation with other KTH departments has become increasingly important. In a long-term perspective, both the emphasis and the geographical location of all KTH's IT related operations must be carefully coordinated in order to provide opportunities for optimal cooperation both within IT and together with other technologies and areas of knowledge. This will create better opportunities for KTH's groundbreaking, international IT activities to retain and strengthen their position.

Biotechnology and pharmaceuticals

Biotechnology is the operational area at KTH's which receives most attention both as concerns its scientific content and the industrial exploitation of its research results. The Biotechnology Department has, in a relatively short period of time, grown to become one of the largest departments at the university. Even if the publicity surrounding KTH's activities within Biotechnology can be considerable, this science is actually currently represented in many other KTH research areas as well. Research connected to biotechnology is carried out generally speaking throughout KTH and, taken together, is twice as large as the Biotechnology Department.

Biotechnology is vital for Sweden's industrial and economic development, not only for new pharmaceuticals and methodological development within medicine, but to a similar degree for the forestry and foodstuffs industry and for areas touching on the environment and energy. Genetics, research into the structure and function of proteins and research on biological processes and material - they are all interwoven into technological and scientific research which provides the preconditions for scientific and industrial development in a huge spectrum of fields of endeavour.

In a future pharmaceutical industry chemical and biological technical production research will be increasingly important. This should be strengthened within KTH and regarded as a further development of the university's chemical process expertise.

In its current position as methodological developer, the technical platforms developed at KTH will benefit all Swedish biotechnical research. KTH therefore forms the national hub of biotechnical research, and will continue to create new applications and new products for the pharmaceutical industry. Progress made within biotechnical research at KTH will also contribute to innovative materials product development within, for example, the pulp and paper industry and the packaging field. Biotechnical research concerning the storage and production of energy is a new field that will also be of immense future significance.

Technical bioscience

The borderland between technology, biology and medicine is arousing increasing interest. Increasing demand for care – in its widest sense – makes increasing demands on society's resources. This requires a well-developed interplay between medicine and technology in order to develop new forms of treatment and to streamline care operations from a systems perspective.

Crossover research becomes a cornerstone when biology, medicine and technology grow together. Traditional medical technology, which was primarily aimed at the development of apparatus and methods for medial care, already has an established, dynamic technological research field with clear connection points to medical research.

Developments within health and medical care open up new, urgent research areas, largely caused by the increasing number of older people in the population. Alongside developments in medical technology KTH, in close cooperation with the Karolinska Institute and other partners, carries out multi-disciplinary research and education within the broad field known as Technology and Health. Research concerning technical solutions and systems is initiated and coordinated based on preventative health and medical care perspectives. These research activities promote an environment which encourages innovation and product development involving companies and care providers.

Research on biological and biocompatible materials is a central, and growing, field in which chemistry, polymer technology and materials science play essential roles together with several other branches of physiological and medical research. Biomechanics works to describe the human body's functions, primarily using methods borrowed from engineering science; for example its ability to build models and simulate processes is extremely valuable.

Exchange of knowledge between technology and medicine is a two way street. Medical expertise on how human beings function is often used as a source of inspiration for new engineering science theory formation and modelling. Entirely new concepts concerning the understanding of

human thought patterns and mechanisms for robots were born out of this multi-disciplinary research.

Materials and nanoscience

Nanotechnology is probably the most important development within traditional technology this century. Put simply it can be described as the technology that decreases components and tolerances to a level of between 100 and 0.1 nanometre. Nanosystems are characterised by important relationships between surface and volume, which makes surface characteristics extremely important. Nanosystems often break the laws of "normal" physics due to the shortness of the wavelengths, and therefore time scales, involved. In a more visionary fashion, the goal of nanotechnology could be described as using atoms as the smallest particle to manufacture our material world in the same way as we currently build up complex IT structures using "bits".

Current research within nanotechnology is often based on developments in traditional engineering sciences which create new concepts and opportunities. Some of the practical areas of application for nano and microtechnology are found within medical technology in which smaller scale components can mean totally new forms of surgery treatment. Within production technology, higher levels of precision can mean better efficiency and longer lifetimes for mechanical systems.

Materials science utilises improved defect control to create lighter, but at the same time stronger, materials. The shorter scales bring totally new scientific phenomena which must be controlled, but they also bring new opportunities. By combining materials science with biotechnical research, new concepts can be developed for the manufacture of a new generation of bio-composites.

Nano and microtechnology possess the prerequisites to revolutionise technical research within important, classical engineering fields. Compared with the processing research within materials and production technology many years ago, the equivalent methods and tools must be developed within the nano and microscales in order to enable the development of new processes and products. As all these applications belong to KTH's core operational areas, it is essential for KTH

to establish powerful networks between nanoresearchers within the various technical areas as well as establishing external networks, primarily with medical researchers.

Urban engineering

The central question to be answered by the built environment's functionality concerns its use, whether it be individual buildings or entire urban districts. One of the most promising research fields formulated during the last century was what Herbert Simon called "The sciences of the artificial". The background was an observation that human beings live to a decreasing degree in a natural world and increasingly in a world created by humans themselves. This highlighted the necessity of a science of the artificial in addition to the natural sciences. Simon considered that one central area within such a science was that of the built environment.

KTH possesses, and must continue to do so, considerable strength within urban studies. It is essential to formulate such strengths in terms of the planning process and project management which construction primarily requires, with a highlighted connection to general engineering scientific subjects.

Consequently this area shows research and development that is clearly separate from other research at KTH. KTH's engineering science activities must here be combined with a mixture of social sciences and economics. This means that the area may almost be perceived as one of the new, integrated scientific fields. KTH possesses a unique opportunity to develop this in competition with, for example, leading schools of economics and other multi-faculty universities. KTH's competitive edge is that engineering expertise is a key component within this type of research and education.

The built environment, regarded as an infrastructure, bears increasingly great importance for both competitive edge and welfare in an interwoven, mobile society. The network theories and planning methods developed for society's infrastructural systems have also proved to have great relevance for many other applications. Research and education on planning in its widest sense, with a greater or lesser connection to engineering, is and will continue to be one of the areas of excellence at KTH.

Energy technology
– production and utilisation

For decades KTH formed an important resource for industry and society when the Swedish energy infrastructure was created. Hydroelectric power facilities were expanded by KTH engineers, new concepts for power transfer were created by KTH researchers in cooperation with industry, Swedish nuclear power technology was born at KTH. Sweden's prominent position as concerns pumping processes for cooling and heating are also based on work carried out at KTH.

This competence has then been added to in the form of valuable expertise in the new technologies. The world is facing a change in its energy infrastructures that, in both the short and the long run, will require major research investments. In order to successfully manage future energy supply and provide the preconditions for climatic development which does not threaten human life, opportunities for a reduction in the use of energy must be utilised and new ways of generating and distributing primary energy developed.

New technological research is necessary to achieve this, for example for the development of more efficient climate control methods and production and use of electrical energy, but also as concerns production and use of hydrogen gas, for transport and for electricity and heat production. A great deal of energy supply can be improved with more efficient use of energy, however it is also necessary to develop new primary sources of energy in order to be able to replace fossil fuels. Solar and nuclear power in various forms are currently the only possibilities.

Through its breadth of engineering sciences, KTH has a unique opportunity to establish itself as a leading European research actor within the energy field. KTH should, in order to improve its visibility in this area, gather all its energy research into a network type meta-centre. Such a centre would be well accepted by the Swedish energy industry and there should be a clear emphasis on commercialisation of new products, new technologies and new business concepts.

Sustainable development
– engineering's environmental science

Sustainable development has become a concept meaning positive, future societal development. In spite of the fact that many question marks remain concerning exactly what sustainable development is and how society is to achieve it. Social objectives may come into conflict with practical functions and short-term economic requirements for profitability within industry and business.

One reason for this lack of definition is that there are no quantitative, generally accepted criteria for sustainability: locally, regionally or globally. Where should society begin and in which way can such criteria be further developed? The overwhelmingly important task for society is to

develop qualitative criteria which work in practice to support decisions in the move towards sustainability.

This type of information technology is a strategically vital research area for KTH and is aimed at setting up realistic goals and strategies in order to be able to follow up the work of sustainable development. Active research is already underway in various parts of KTH with the aim of contributing to sustainable development. This technical environmental research is becoming increasingly integrated with the various fields of technology which has been an aim at KTH for some time. Examples of such areas include new materials, life cycle analyses, product design, environmentally sound energy technology, environmentally sound construction, new transport methods and new processing technology for wastewater and garbage. KTH is already well on its way to fulfilling its social responsibility within these areas.

Currently there are no standardised, quantitative methods describing how to use a sustainability perspective to characterise natural systems (water, land and atmospheric systems), assess technical investment alternatives (broad quantitative, technological assessments) and follow up the various technological solutions and systems (various forms of accounts and reporting). Improvements in technology and information technology are not enough to achieve sustainable development. At least as much emphasis must be placed on the socio-economic dimension, which primarily consists of the needs of the various actors as well as their interests and actions. The current information structure for sustainable development is impossible to survey, heterogeneous and difficult to access. KTH possesses the necessary preconditions to take a leading role. Its vision should be a new information structure for technology and environmental characterisation that also takes the socio-economic dimension into consideration.

Technical mechanics

Technical mechanics, consisting of solid and fluid mechanics as well as technical acoustics, is another strong area at KTH which is reflected in the number of PhD students graduated from, or currently studying at, the university. The area is of major importance to Swedish industry and society generally. Mechanics is currently undergoing dissemination into new areas of application as it has functioned as a development engine for calculation tools and new measuring methods with broad applications.

One example of a situation in which the various parts of technical mechanics interact is within

new developments in paper technology. There are many new areas within, for example, the more traditional vehicular engineering industry aimed at the development of a more efficient and environmentally friendly combustion engine. Flow modelling with multi-phase aspects is also an important ingredient in the new fuel cell technology. Within combustion and other areas, knowledge on such subjects as flow, materials and acoustics is being combined with new methodological development to control and regulate complex, dynamic processes. Some of the major scientific calculations carried out today in the world are aimed at these areas and are occurring at the same time as the development of strong modelling support, consequently these calculation tools are increasingly high quality and are rapidly put to industrial use.

Mechanics according to the above description can be regarded as an engineering scientific discipline for the development of new technical systems within new areas of application such as materials science, process technology, environmental research, climatic research, energy transformation processes and structural optimisation as well as moving into micro electromechanical systems and biosciences. Technical mechanics also provides good opportunities for the practical experimentation that forms a vital part of an engineering education.

Architecture and design

Architecture and design deals with the relationship between technology, the human being and design, in which creation of form is the key concept. The ability to develop a three or four-dimensional thought process during the creation of form is the overall goal of architectural education and research. The technical universities already possess an artistic creative platform in their architecture courses and research and in their artistic development activities.

The primary characteristic of educations that include artistic elements is that they are teacher-intensive with a focus on project work. One demand made to government is therefore that these architecture courses must be recognised as educations which include a genuine mix of creativity and technical development and that they should consequently be allocated the equivalent design courses for both these elements.

KTH should develop a course within industrial design in which much of the methodology from the architecture courses can be utilised. Such educations require close cooperation with the engineering science subjects, not least industrial economics and technical mechanics, as well as a solid multi-disciplinary research base and a well-expressed emphasis on the intangible. If the level of creative competence is high enough, long-term preconditions can be created for many new types of industrial growth.

The School of Architecture's opportunities to realise positive, future development must be assessed as good considering the high level of interest for these courses that is reflected in the large-scale flow of students from other prominent universities.

New products and new production technology

Technology is creative. It is difficult to imagine new technology and technical development without imagining new products and new ways of producing these products. Technical universities have always been involved in research around product development and production technology; previously often on an extremely large scale such as within the steal and paper/pulp industries. Today, perhaps, the trend is towards the smaller scale such as in the new engineering industries connected to direct consumption.

It is vital for KTH's higher education and research to expand competence within the product development area and strengthen links between product development and production methods. The increasing complexity of modern technical products also demands that the products' physical performance, conduct and impact on the environment and human beings is studied and analysed using a holistic approach.

Configuration, simulation and visualisation tools interact with CAE (Computer Aided Engineering) tools when studying the functional efficiency of these products. Access to this common product, process and resource data in an integrated environment creates the preconditions for flexible, innovative and rapid product development. However product development is not only connected to the manufacture of products but is also closely linked to their actual use. This usage is close the human as a consumer or to its use in the workplace. The success of a product, and consequently its financial value, is that awarded by the user. This opens a new field of research in which technology, work science, psychology and sociology meet, a field which will provide economic growth.

The research profile which emphasises scientific calculations and simulation of industrial processes requires powerful calculation capacity. KTH possesses Sweden's leading competence within technical production research. By grouping these research areas around the utilisation of KTH's parallel and super computer resources, a competence centre for simulation and visualisation can be established. Research goals for the centre would include the development of efficient, flexible modelling and simulating methodology and an information platform as effective support to product development activities.

Mathematics with applications within engineering and natural sciences

Mathematics is playing an increasingly important role in our modern, hi-tech society. Totally new areas of application are being identified as older fields are developed. For example, IT would be impossible without the tools provided by mathematics in the form of models for an increasing number of situations, which has in turn required the formation of new theories.

Mathematics at KTH maintains high international class within a number of core application areas. New areas such as financial mathematics are also under development. Pure mathematics as a core subject forms the foundation of, and a necessary precondition for, all applied maths. In the engineering and natural sciences of the future, the interplay between mathematics and its applications will become increasingly important and KTH has, as do all the premier technical universities, an ambition to maintain and develop leading edge competence within the subject. Good synergy effects can be achieved through closer cooperation with the University of Stockholm in a Mathematics Centre where competence can be brought together.

All engineering education must rest on a mathematical foundation. It is, in fact, often lack of understanding of mathematical concepts that limits engineering expertise. If KTH is to continue awarding degrees to the most eminent engineers, then mathematics must be prioritised within the various KTH programmes. KTH must continue to offer the opportunity to students who are especially interested in mathematics to develop these skills via accelerated studies. It is also vital that new students arrive at the university well equipped with mathematical know how. KTH will contribute to this through further education for upper secondary school teachers.

More detailed knowledge of mathematics is also a precondition for continued work with mathematical teaching methods for all educational fields. KTH's other activities such as IT, work science and teacher training provide unique preconditions for such an approach which will, in the long term, enhance the quality of the education on offer at KTH.

Creative and competent individuals

Humboldt's ideas live on

Humboldt's ideas about universities as autonomous institutions where free, independent research may be carried out must continue to be KTH's guide. Only under such conditions can the university recruit the scientific specialists it needs.

Respect for, and trust in, the individual

In order to achieve its goals, KTH must be a workplace in which staff, students and visitors are pleased to stay and where personal development and responsibility are stimulated. The working environment will be characterised by respect for, and trust in, the individual based on the understanding that everyone is prepared to take responsibility and to do a good job.

KTH will continue to invest in competence development, management development and dialogues between manager and employee. Special efforts will be made to develop methods to improve the psychosocial working environment and in-house communications.

Intensified diversity and gender equality activities

Management of KTH and other universities has, during the last decade, undergone a process of rapid change: from a collegiate leadership in which consensus guided decision making to a fruitful interplay which includes perspectives from grassroots and clients. The trend is towards management within the university world as becoming a task in itself and not, as previously, a job

for presidents only. Nowadays deans, heads of department and other leaders within the organisation must all carry out management tasks.

KTH intends to work for the creation of continuous management development. It is essential that KTH in its entirety is able to identify with its management culture. A university sets one of society's strongest examples and, in the future, KTH must carry out its diversity and gender equality activities much more forcefully. These activities will be based on the policy document concerning these issues that was established by the Board of KTH in 2003. Increased gender equality and promotion of diversity within KTH are preconditions for continued development of the university and must consequently be regarded as part of KTH's quality assurance activities. The lack of gender equality among the teaching staff has many underlying causes including the relatively unattractive working situation and limited opportunities for permanent employment. These are important problems to attempt to solve. A broadening of subject areas when advertising posts plus individually aimed affirmative action may be able to contribute to a more even gender distribution within the higher academic posts.

Innovation and industry close to KTH

New career paths for engineers and researchers

KTH has a long, successful tradition of industrial cooperation. Strengthening and improving this is, and will continue to be, a natural part of future KTH operations. When industrial structures and methods of creating economic growth change, KTH's working methods must make the corresponding shift. Students today, for example, regard the opportunity to start their own businesses at being at least as attractive as a traditional career in a large company. In the same fashion, perhaps to an even greater degree, today's researchers often find the idea of starting a spin-off company as interesting as publishing their results in scientific journals.

Efficient commercialisation and innovation routines

At KTH there is no conflict between its research and commercial operations. In order to become a leader in this field there must also be an efficient KTH policy for commercial activities. During the next few years, KTH must develop an innovations strategy so that KTH researchers will feel that they enjoy reasonable preconditions for the development of their research both scientifically and industrially. This includes, as well as a new approach to the creation of value and development of the regulatory and financing systems, the development of the necessary support resources to increase benefit. Such a strategy must be created in cooperation with the government and industry.

KTH will work for changes to legislation concerning patent and copyright rights for employees' research results in the direction of the Danish system, in which universities possess the primary commercial rights to inventions. This would enable KTH to, through its 90 percent government resources, contribute to Swedish economic growth to a greater degree. It would also provide the university with an opportunity to build up an efficient innovation system across the entire breadth of the engineering field.

The Swedish and European research landscape is changing in many other ways too. KTH is currently working and will continue to work in many different types of networks, including the EU's framework programmes, which requires a clarification of the roles of the various actors. KTH is, and will increasingly become, an academic partner in such networks that also include industrial companies and industrial research institutes. In order to achieve maximum strength and greatest possible economic benefit within the framework programmes it is essential that KTH, and institutes and companies close to KTH, work in a coordinated manner.

KTH's role in research cooperation

With full respect for the roles of the various parties, stakeholders and established networks, identifying suitable and efficient forms of cooperation is an urgent task. This may apply to cooperation forms within projects or taking joint responsibility for staff, premises and experimental resources. It may also mean working jointly as coordinators of major European programmes. Institutes may, in this scenario, even take over part of KTH's traditional tasks within the applied subjects.

Attachment B:

Källblad, Emma & Anders Broström (eds.) for the KTH Faculty Board & Vinnova. (2005) *The KTH Entrepreneurial Faculty Project*. (VINNOVA Report VR 2005:13; November 2005; 132 pages) Stockholm: Vinnova (Swedish Agency for Innovation Systems).

VINNOVA REPORT
VR 2005:13

THE KTH ENTREPRENEURIAL FACULTY PROJECT

ROYAL INSTITUTE OF TECHNOLOGY

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About VINNOVA

VINNOVA, the Swedish Agency for Innovation Systems, integrates research and development in technology, transport, communication and working life.

VINNOVA´s mission is to promote sustainable growth by developing effective innovation systems and funding problem-oriented research. Through its activities in this field, VINNOVA aims to make a significant contribution to Sweden´s development into a leading centre of economic growth.

The VINNOVA Report series includes external publications and other reports from programmes and projects that have received funding from VINNOVA.

This report

summarizes the findings of the KTH Entrepreneurial Faculty Project.

The project has enjoyed active participation from a number of partner organisations (see Appendix I).

Particular support has been found in the Innovation Bridge, Stockholm, co-funders of the project.

SISTER, the Swedish Institute for Studies in Education and Research, has supported KTH throughout the project.

Strong cooperative support and additional co-funding, which has made it possible to develop this report further, has been provided by VINNOVA.

The KTH
Entrepreneurial Faculty Project

Stockholm
November 2005

VINNOVA´s Preface

VINNOVA's mission is to promote sustainable growth by developing effective innovation systems and funding problem-oriented research. An important part of this mission is to support the efforts universities undertake to develop themselves into “entrepreneurial universities”. In this context, KTH’s project, the Entrepreneurial Faculty Project, is a promising initiative.

The project addresses important aspects of how to facilitate interaction between a university and its stakeholders in industry and society in a deliberately broad manner. The report presented here summarises three types of information: lessons learnt from study trips undertaken to leading universities in Europe and the United States; seminars organized by the project; and, other bench learning activities. It also discusses how KTH may proceed in becoming more entrepreneurial as a university. The fact that the Faculty Board at KTH has been the owner of the project contributes to giving it legitimacy within the academic community, which is essential for a successful implementation of the suggested actions.

VINNOVA wishes to express its gratitude for having been invited to take part in KTH´s knowledge trips to universities in other countries as well as, together with KTH, having organized seminars to discuss the findings and recommendations of the project. The Entrepreneurial Faculty project has been a valuable source of knowledge to VINNOVA about how other universities work with third mission activities and this knowledge has impacted the design of VINNOVA´s new Key Actors Programme. This programme aims at developing competence, working methods and structures to make Key Actors, mainly universities, in the Swedish innovations system become more professional in their roles in out-reach and the commercialization of research. While the project has produced valuable knowledge about differing models for third stream activities, it at the same time is an example of a fruitful approach of how to work with questions of attitude and cultural change within a university.

We hope that this report will stimulate further discussions at KTH about relations with stakeholders (industry, organisations, government agencies etc.) and will also have impact at other Swedish universities as well, becoming a starting point for various activities in this important field. The authors of the report are responsible for conclusions and suggestions presented.

Sven Gunnar Edlund

Director, Head of Division

VINNOVA

KTH, Today and Tomorrow

KTH's role in Sweden's industrial development remains as important as ever to Faculty and the KTH community. KTH has a long, successful tradition of industrial cooperation. Strengthening and improving this is, and will continue to be, a natural part of future KTH operations. As industrial structures and methods of creating economic growth change, so too must KTH's working methods. Students today, for example, regard the opportunity to start their own businesses as being as attractive as a career in a large company. Companies seek research expertise internationally, whilst also wanting to strengthen their local capabilities. Many researchers consider the idea of licensing a technology an exciting complement to publishing results in scientific journals. These are changing times for us all.

On campus the participation and influence of the rest of the world on KTH's research is becoming increasingly evident. Research – especially at the engineering and natural sciences faculties – has a clear ability to impact areas with links to society and industry. Addressing social and industrial issues requires knowledge and resource partnering. Consequently KTH must ensure that actors from outside the University, in both the public and private sectors, contribute to problem descriptions, participate in decision-making concerning projects, and, often, contribute to funding research. KTH's research is increasingly financed – currently to two thirds – by funding outside direct government allocations for research and doctoral studies; this is a trend that will only advance.

The Swedish and European research landscape is changing in many other ways too. KTH currently works in many different types of networks, including the EU's framework programmes. KTH is, and will increasingly become, an academic partner in broad networks that also include industrial companies and other research institutes. In order to achieve maximum strength and greatest possible economic benefit within these relationships, it is essential that KTH, and institutes and companies close to KTH, work in a coordinated manner.

It is only as a technical University within Europe that KTH's position be retained and strengthened. Developing KTH to one of the leading European technical Universities will be the most important task for the next years and sets the ambition of KTH's vision.

In KTH's Development Plan, drawn up in 2002, KTH's Rector, Anders Flodström, wrote:

"At KTH there is no conflict between research and commercial operations. In order to remain a leader in this field however there must be an efficient KTH policy for commercial activities. During the next few years, KTH must develop an innovations strategy so that KTH researchers will feel that they

enjoy reasonable preconditions for the development of their research both scientifically and industrially. This includes, as well as a new approach to the creation of value and development of the regulatory and financing systems, the development of the necessary support resources to increase benefit. Such a strategy must be created in cooperation with the government and industry".

The Entrepreneurial Faculty Project was undertaken with this goal in mind. With full respect for the roles of the various parties, stakeholders and established networks, identifying suitable and efficient forms of cooperation is an urgent task. Much effort has been invested in developing KTH's innovation system over the past decade; it is now time to ensure these initiatives are properly embedded in KTH's culture and coordinated at the right strategic level. It is also appropriate to seek out new practices and set new ambitions.

This work must be owned by KTH if it is to affect the fabric of our campus life. Changes in knowledge production, however, require the support and input of partners who are both committed and innovative. In working to address this task KTH as been fortunate to find such partners in the Innovation Bridge, Stockholm and VINNOVA, the Swedish Agency for Innovation Systems. These organisations have become not only financers but long-term colleagues and together we have enjoyed the process of learning the Entrepreneurial Faculty Project has provided. In particular, the project has benefited from the mentorship of Clas Wahlbin, Göran Reitberger (Innovation Bridge, Stockholm) and Sven Gunnar Edlund (VINNOVA).

The report summarises the findings from bench learning trips made to different Universities. It also comprises conclusions drawn from an international seminar held at KTH in April 2005, with participation from the Universities visited and Swedish peers. The current report has two missions: it gives examples of experiences gained from other universities; it also brings out a set of conclusions drawn under each of the thematic headings of the project and the report.

Although we consider this report a document of the Faculty board, the board has needed assistance to put findings and discussions together. This role has been competently filled by report editors Emma Källblad (KTH) and Anders Broström (SISTER). Dag Lindbo (KTH Student Union) and Lisa Ericsson (KTH) have also contributed to the report.

The next step in the project is to deepen work in a set of selected aspects, and to prepare for the active implementation of some of the policies in the KTH academic system. This is only the start of a process; KTH must continually reflect on its abilities and relevance if it is to continue to serve the society of which it is part. In this process the KTH Faculty Board will continue to play a pivotal role in taking initiatives and coordinating activities.

We thank all participants in this challenging development process so far and look forward to productive future collaborations.

Folke Snickars

Dean of Faculty, KTH

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Introduction

To undertake successful technical research is to behave entrepreneurially. Researchers are called upon to continuously identify opportunities and act accordingly – a behaviour that readily corresponds to that of a successful entrepreneur. But what characteristics shall a modern, successful technical University have? Interestingly, many people suggest the very same answer: entrepreneurial traits are needed.

Having said that, let us clarify that the term entrepreneurial is *not* used here in the limited context of firm creation, or even in the limited context of business. The rest of the report will expand on what *is* meant by entrepreneurial traits, by providing examples from visits to a number of leading Universities and by discussing how KTH can become a twenty-first century success story. The term 'entrepreneurial' is used over 'innovative' in the report because the former concept encourages *enterprise* – "a wilful effort in institution-building that requires much special activity and energy".[1]

Vision: the entrepreneurial University

The values of entrepreneurship have had significant impact at the higher levels of organisational hierarchies in many sectors. In the commercial world, even the largest organisations have for a long time sought to develop entrepreneurial characteristics to stay ahead of competitors. Hospitals, government departments, unions and charities have likewise sought to introduce intelligent entrepreneurial actions into their management. In a world of constant change, organisations need capabilities to adapt, learn, make calculated investments and exploit opportunities. This argument seems to be valid also for Universities.

But what does it mean that a University should become more entrepreneurial? Does it imply that new central functions and stronger governance are needed? Without doubt management functions at Universities are growing more important as economic and organisational pressures increase. But a strong transition of executive power towards central University management seems to have unwanted consequences for the cause pursued here. Universities, possibly more so than businesses, thrive because of the entrepreneurial abilities of the people they employ. Entrepreneurship is associated with a high degree of freedom for experimentation. The question becomes, there-

[1] Quote from Burton Clark, 1998, *Creating entrepreneurial universities: Organizational pathways of transformation* , p4. Pergamon Press.

fore: how can a University build managerial and professional capabilities without harming, indeed, with the purpose of stimulating, its most precious resource – the entrepreneurial capacity of its researchers?

The conflict cannot be fully resolved, but the introduction of stronger management functions with strengthened entrepreneurial abilities at the central levels of the University can be justified as beneficial. Faculty and students depend on a large number of University characteristics to fully develop their entrepreneurial skills and to achieve excellent results: the resources available for world-class equipment and facilities, funding for the most important new initiatives or projects, etc. The emerging realization that these frameworks for academics are dependent on a large set of entrepreneurially minded activities on behalf of the University as a whole may create greater acceptance for continued reconcilement of new managerial values with traditional academic ones.

But let us return to the main question: what does it mean that a University must become more entrepreneurial? Whilst important, functions at the central University level can never provide a complete answer. An entrepreneurial University must be characterized by active, entrepreneurial efforts of its "Entrepreneurial Faculty", supported by an increasingly professional administrative organization. That's the starting point for this endeavour, and that is why we call it the Entrepreneurial Faculty Project (EFP).

KTH's Faculty, through the Office of the Faculty Dean, have actively led this project debating what types of support and activities they consider it appropriate for their University to develop. Perhaps it is through this type of approach that the conflict between individual freedoms and central support can be positively addressed? KTH's Faculty have reflected deeply on the aims of their University and the initiatives that should be developed to support these. A successful entrepreneurial University requires the permission, insight and support of its entrepreneurial Faculty if it is to develop in a manner that enables them.

CASE STUDY I

Scholars on the Entrepreneurial University

In recent years, the future of universities as organisations and their role in society has become a subject of intense academic debate. In an analysis of five European universities, Burton Clark made the term 'Entrepreneurial Universities' widely known. Clark defines an entrepreneurial University as "a type of modern University that stands on its own feet in order to adapt, on its own terms, to a highly complex and highly uncertain world". Clark identifies five elements that he views as an 'irreducible minimum' that enable universities to transform. These include:

1. A strengthened steering core
2. An extended developmental periphery e.g. professional relationship handling
3. A diversified funding base
4. A stimulated academic heartland
5. An entrepreneurial culture

Clark emphasizes that an entrepreneurial University is defined by a common culture that supports outreach activities. Critics of Clark have questioned this latter remark – is it really meaningful to speak of such a thing as a common culture in the diverse departments of a University?

Another well-known scholar in this field, Henry Etzkowitz, has similar views on the future of universities as 'entrepreneurial'. Etzkowitz points to the apparent conflict between the demands on the University, between increased interdependence (interaction with industry and public organisations) and increased independence. He suggests that "hybrid organisational forms" must be created to realise both objectives simultaneously.

Clark, B. (1998), Creating Entrepreneurial Universities: Organizational Pathways of Transformation, Oxford: Pergamon-Elsevier Science.

Clark, B. (2001), "The Entrepreneurial University: New Foundations for Collegiality, Autonomy, and Achievement," *Higher Education Management*, 13(2). 2001; 9-24.

Etzkowitz, H. (2004), "The evolution of the entrepreneurial University", *International Journal of Technology and Globalisation*, Vol. 1, No. 1.

Methodology: learning from and with partners

We have championed the idea of organized knowledge exchange with academic partners as a means to find inspiration and to build a foundation for strategic discussions and actions at KTH. To learn from and together with the academic world is, just as argued in the case of entrepreneurship, a strong University tradition. It has also proved to be a way to bring leading representatives from Faculty and staff together around important initiatives. KTH has already benefited from the international network that has been activated through this process and hopes that these effects will remain valuable for the University in its ambition to continuously work with its national and international partners in search of new ideas, trends and possibilities.

There are four ways to benefit from recognized good practise of others: replicate it, adapt it, experiment with it, or get some further ideas that are inspired by it (Bardach, 2004)[2]. Copying schemes or replicating policies found at another University is certainly not a productive approach. The ambition of the EFP lies rather at the latter end of Bardach's imaginary scale.

On a separate note, this project has not sought to identify "best practise" - neither in the form of a particular scheme, nor in a particular institution. Instead, it set out to identify and map different practises which have an interesting appeal. The direct effect of these findings is ideas, inspiration and orientation of current developments, facilitating continued change processes in different parts of KTH. That such direct effects have been possible is due to the fact that leading KTH Faculty and senior executives have been actively involved in the project and present at the study tours.

Reality check: differing frameworks for entrepreneurship

Studying tendencies towards entrepreneurial behaviour at a number of institutions, we recognize the risk that any analysis of schemes and strategies may be influenced by national systems and frameworks to such a degree that rigorous analysis and comparison becomes ineffective. To reduce that risk, we have investigated some of those frameworks, arguing that differ-

[2] Bardach, E. (2004), "Presidential address – the extrapolation problem: how can we learn from the experience of others?", Journal of Policy, Analysis, and Management, Vol. 23, No. 2, pp. 205-220.

ences made visible add strength to our analysis.[3] Summing up experiences, we conclude that:

- Regarding the general standing of institutions, KTH performs moderately in aggregated measurements such as the Shanghai Rankings and the TIMES Higher University Rankings. Further studies reveal some seemingly problematic indications about KTH's long-term position as a University: a very low Faculty / student ratio, and a relatively low degree of internationalization in the student body and in the PhD-student population (studied as percentage of foreigners). Both these factors have a bearing on KTH's ability to offer competitive education (in particular on a Masters level) and to strengthen its presence in global research networks.
- All the compared Universities, except KTH, have substantial financial assets, primarily in the form of land and buildings. The availability of assets is a precedence for an ability to make investments and to build institutional independence. In this sense, assets in endowment funds are particularly important. Such funds are also lacking at KTH.
- All the compared Universities, except KTH, have the right to charge tuition fees, at least for non-EU students. Such fees play an increasingly important role for University income.
- Total cost for employing PhD-students are significantly higher in Sweden that at any other compared University. This has substantial impact for the respective Universities' abilities to attract industry funding for research projects.
- Technical research and advanced higher education is more concentrated in the other compared national systems than in Sweden. It is notable that the two Universities that are of similar age and have similar histories as KTH (Delft and ETH Zurich) have a significantly higher level of direct funding from Government.

These differences create significant challenges for KTH and are often debated in the Swedish context. Whilst wanting to add to this debate, KTH does not wish these obstacles to prevent proactive action, so has chosen to progress this report in knowledge of them as "conditions to be challenged" rather than stops to any action.

KTH also considers it important to note that it was established and developed as a technical University with a mandate to respond to the needs Swedish industry. The University has worked closely with an ever more

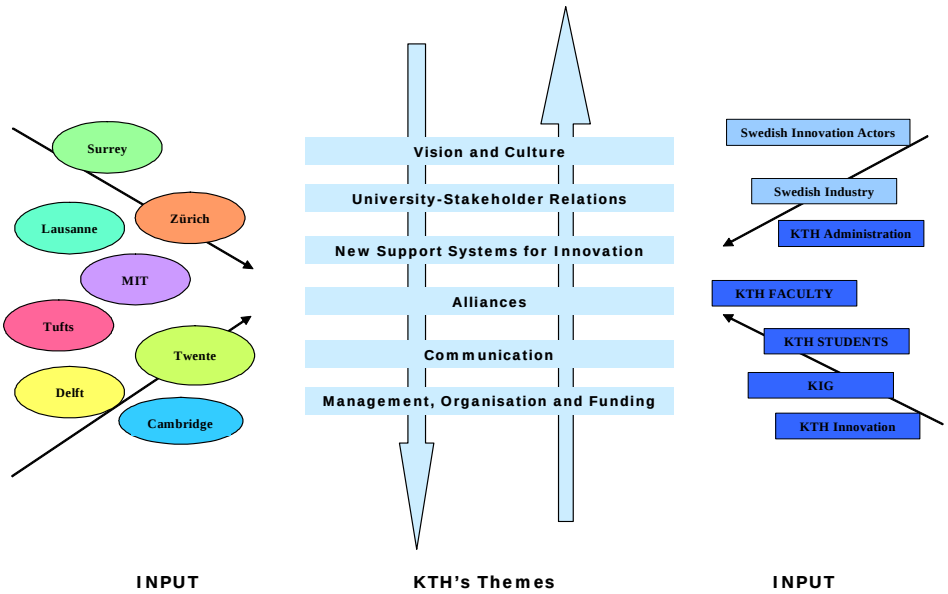
[3] For details, see Appendix X.

diverse range of Swedish companies through-out its history, and remains proud to do so today. This relationship with industry has been close, influencing both education and research. As Sweden's strong economic standing makes clear, it has been a successful relationship for all parties. KTH can be seen as champion of "use-inspired basic research", a distinction that continues to give great potential to both the University and Sweden's economy.

Themes of entrepreneurial action

Between November 2004 and February 2005, KTH's Faculty was fortunate to journey to some of the most progressive Universities found in the world today and meet with some of the key actors behind the development of these institutions. In the UK the Universities of Cambridge and Surrey were visited, in Holland, Delft and Twente, in the USA, MIT and Tufts and in Switzerland Zurich and Lausanne. KTH wishes to pass on its sincere thanks for their active participation in the EFP to these Universities.

These journeys were undertaken with clear purpose – to enable KTH to reflect on its own progress as a University embedded within a complex modern economy, and to build further KTH's relationships with these Universities. This report collects reflections on these visits, as well as outcomes and perspectives revealed in a series of seminars and meetings that has accompanied the experiences from visits.



The main part of this report is structured around six "Themes" each of which has been found a useful flag pole around which to collect thoughts

and actions. The area of innovation and relationship management at Universities, sometimes called the "Third Mission" in Sweden[4], is necessarily substantial and it is recognised that no theme is a discrete entity; neither have explorations been comprehensive. What has been explored and the theme format, however, provides a useful starting point from which we can extend our considerations.

[4] When the project was started we used the phrase "Third Mission" to label a series of activities and approaches. As we have explored different environments and reflected on what KTH wants to achieve, it has become more appropriate for us to drop talk of a third mission, considering that innovation and relationship development must be part of the University's first and second missions, education and research.

Feedback from KTH's April Seminar

What is the modern University? Perspectives from the University of Cambridge and University of Surrey

Dr Christopher Padfield, Director of Strategy for the University of Cambridge argued that today's universities must "decide very clearly *what they want to be* and *what they want to achieve*, in order to be able to negotiate it with their partners and maintain their independence". "Cambridge", Dr Padfield continued, "determines its own agendas, and thrives, as do private companies, by the rightness or wrongness of its choices, and by whether it succeeds in taking its stakeholders with it". Surrounding members of society, whether corporations, citizens or the government, are a University's stakeholders. In an increasingly complex and competitive world a modern University, therefore, requires a strong sense of its own identity complemented by strong relationships, if it is to thrive. The Faculty of a University, together with its administration, have a responsibility to set their institution's agenda and support it in building good relationships, assisting the University to flourish as a corporate entity, as well as a base for their research.

"Academics", said Christopher Padfield, warned however, "are as independent minded as cats. And one important thing to know about cats is that you can not herd them".

Judging from the reactions, the assembled Swedish academics appreciated this metaphor.

"Another important thing to know about cats, is that cats are always willing to go where there is cream", continued Dr Padfield, "So when it comes to making working with industry attractive for our top researchers, the basic question [for a University] is: what constitutes cream?"

Cream at Cambridge, it seems, centres on the academic freedom to conduct research with the best partners. Cambridge researchers have substantial freedom of operation; they are not contracted for any number of hours or tasks but can define their own priorities. The University has developed an active approach to helping its staff pursue quality relationships through activities such as the Cambridge Partnership Group.

When asked to consider how toady's Universities *as organisational structures* can be developed to promote innovation and outreach by KTH, Dr Ben Ferrari, Head of UniSDirect at the University of Surrey, replied that a University must address its leadership, organisational structure and strategy. Quoting Professor Burton Clark of UCLA (see above), Dr Ferrari described how Surrey had learnt to "stand on its own two feet". Dr Ferrari argued that, whilst institutional and Faculty independence lie at the heart of any University activities, this must be complemented by adept governance and purposeful support. Dr Ferrari stressed that these must function to reinforce one another and the University of Surrey has sought to achieve this by combining Faculty and administration skills in a strengthened steering core that takes strategic decisions for the University. The University has, for example, chosen to invest in an Advanced Technology Institute to promote cutting-edge multidisciplinary research in electronics. It has also chosen to offer higher levels of salary to staff that combine excellence in their field with a commitment to innovation. Professor Michael Walker, R&D Director of Vodafone, recently described the University as "remarkable for its ambition, innovation and professional approach" illustrating the impact that a "joined up" organizational focus has had on Surrey and its partners.

Entrepreneurial Faculty: Vision and Culture

Introducing the theme

Whilst dedicated programmes and staff, the legislative environment and funding opportunities enable University innovation and relationship-building to thrive, in KTH's experience it is important that any such activities stem from a culture that places value on the University's role in society. This type of culture requires a vision; perhaps best thought of as "permission" to act. It also requires leadership, if it is to be sustained. KTH wanted to explore how other Universities act to support a culture that promotes innovation and out-reach within their organisations.

The issues

Ensuring innovation and out-reach are part of the fabric of a University

KTH's mission, "Vetenskap och Konst", translates as "Science and Craft"[5] and clearly links research to its application in the world. KTH's industrial heritage ensures that good links with industry are part of its culture and activities such as the "ex-jobb" scheme that place many students with industry for project work during their final year, assist in sustaining an environment that places emphasis on the impact of research in society.

Drawing on experiences from the US in particular, it seems that a University's commitment to its relationships with society cannot be understated and that, for an innovative culture to flourish, this commitment needs to be continually supported and re-stated.

With regard to support, KTH has already created a senior Faculty posts with specific responsibility for addressing KTH's role in the third mission; a Vice Rector for Industry and Community Cooperation has been appointed and the Rector himself play a key role in KTH's interactions with society.

For an innovative culture to continue flourishing, it is important that the "Third Mission" is not seen as belonging to one part of KTH or as being outside of KTH's first and second missions, education and research. Innovation and relationship development must be part of the fabric of KTH so

[5] Strictly speaking "konst" translates as "art", in this context relating to practice as in "artisan"

that the whole KTH community can benefit *and participate* in sustaining a productive culture.

Embedding an entrepreneurial culture: students first?

At several of the Universities visited considerable effort had been put into developing the skills and abilities of students to function as key actors in the knowledge economy. The University of Surrey and the Cambridge-MIT Institute (CMI) in particular have initiated some exciting programmes. Surrey's Student Union runs an incubator and educational programme for budding entrepreneurs. CMI runs *Enterprisers*, a programme that builds self efficacy and confidence levels amongst students, in so doing equipping them with skills that will support them in succeeding, whether they enter an established company or start an enterprise of their own. The breadth of this programme impressed delegates from KTH as it addressed innovation as a life skill.

During the MIT visit, the dedicated attention given to student-Faculty interaction was also keenly noted. All speakers who addressed student related issues at MIT stressed the high quality of relations that have developed between students and Faculty. In fact, one distinguished professor went so far as to call coursework "an ancient relic" and that the real source of excellence in MIT engineers is that students and Faculty work together. He also commented that no student should think of his education as a service paid for, nor can teachers think of education as something sold to students. It is an academic relationship that both parts are privileged to be a part of. Certainly, this is something highly desirable for KTH and not to be thought of as out of reach.

Most striking perhaps is the fact that a qualified majority of students participate in regular academic research projects while they are still at an undergraduate level. Some contribute as much as 30 hours a week in research groups. This phenomenon has two implications.

First, it lays a foundation of trust and mutual respect between Faculty and students. It is these foundations that, in the end, empower MIT graduates, current students, and Faculty to some extent, to act as entrepreneurs in the broad sense – to be innovative, visionary and seek out challenges with the confidence to succeed. There is a wealth of programmes and study-related activities at MIT that certainly could not exist at such a high level without this basis of trust. An excellent example of such an activity is the IDEAS Competition, which develops "social entrepreneurship" (see case study II).

The second aspect of student participation in research is that it furthers knowledge exchange greatly. When graduates have had significant experience with the research environment at the institute, they carry with them

both personal connections with researchers and a much greater knowledge of the technologies being researched. Thus, it facilitates technology transfer from academia to corporations, and back. Extensive student participation in research has increased the benefits MIT delivers to its society. This phenomenon has been duly noted by the CMI project (see case study VII), and Cambridge University undergraduates now participate in research to an increasing extent.

Suitable action should be taken to enable this avenue of third mission activity to develop. KTH, as a leading Swedish technical University, should be a driving force.

CASE STUDY II

MIT IDEAS Competition – an innovation challenge with a community service twist

A highly inspiring program discovered during the US visit, the IDEAS Competition hints at the depth of the MIT culture, in terms of innovation, entrepreneurship, student-Faculty interaction and commitment to society and mankind.

The competition provides a structure that supports students' innovations with a public service purpose. That is, creative ideas are supported that will come to benefit communities in need, both locally and overseas. The level of the ideas turned into reality is truly astounding. One team has designed a pedal-powered washing machine for areas of Guatemala that lack electricity, which is very cheap to produce and uses only locally available parts for repairs. They have succeeded where several commercial projects have failed. Another team has made a cooled backpack intended to transport 1200 doses of vaccine for 12 hours on one battery charge, coupled with numerous off-grid ways of charging the battery. Other projects are to solve social problems in MIT's local Boston community, as well.

True to the nature of MIT, this program is designed as a competition. Teams apply to enter and are ultimately judged on the inventiveness, feasibility and community impact of their project. The entire procedure takes place from October to May. The award money must be spent in the following year and is only intended to get the team into the next stage of commercialization.

Throughout the year of competition the IDEAS staff and volunteers organize a range of workshops and seminars to aid the teams in some non-technical issues, such as reaching the intended community, establishing partnerships with local NGOs or developing a business plan. On the technical side, teams draw heavily on the expertise and facilities at MIT to be able to realize creative solutions as real prototypes. This Faculty support is pivotal. It is also pivotal to have a community service spirit at the University, which serves broader purposes as well. Fundamentally though, it is inventiveness and entrepreneurial spirit in the student body that carries the project.

Alumni: a slumbering resource

When discussing student involvement in research and the establishment of a strong University community, there is one more group whose potential importance must be recognized: the Alumni of a University. Having formed a part of a strong, thriving University community, students who move on to careers in all sorts of fields have tended to keep a bond to their Alma Mater. Schemes such as mentor programmes form a typical example of how Alumni and students are mobilized in a University community context. Berkeley makes note of its alumni now working internationally (many of these people having been international students); international links are vital for developing many different types of relationships at all levels.

Initiatives for creating stronger Alumni networks are a relatively recent invention in the Swedish society, where many Universities make increasing efforts to secure further details of these students after graduation.

How can KTH address this theme?

Establish Principles for action

KTH would like to suggest that, in complement to its mission, it establish a set of "Principles" that support and guide action. Whilst unlikely to be controversial, by restating KTH's founding mission and re-invigorating it with these suggested Principles, KTH aims to create an environment in which innovation and out-reach are clearly signalled as approved of and, indeed, actively encouraged. Under these principles KTH considers that a variety of initiatives can be seeded, both by KTH itself as a central unit and, perhaps more significantly, by further members of the KTH community.

The Principles state that KTH should:

- Communicate whenever possible its commitment to innovation and out-reach
- Ensure that out-reach and innovation attitudes and activities impact all members of the KTH community, especially students
- Record, communicate and reward achievements in out-reach and innovation
- Create further opportunities for researchers and students to communicate with each other and society
- Actively encourage the formation of relationships and activities that develop KTH's innovation ecosystem

These principles provide a guide to action. For example, in line with the third principle, KTH's new Schools will be asked to standardise their recording innovation and out-reach activities so that each School, as well as the University, can chart and communicate its impact and progress. In line with the fifth principle KTH is considering hosting a "micro-grant" scheme to which student organisations interested in innovation and networking can apply for smaller amounts of money.

It is hoped that by stating these principles, KTH will also see further "bottom-up" responses from its own community.

Establish resourced support for action

Whilst KTH has a Vice Rector dedicated to this area and the Faculty Board takes a keen interest in progress, it is apparent that there is little resource currently available for planning and implementing *sustained* strategic actions. Deep culture change requires long-term commitment and a programme, rather than project, approach. UK Universities have benefited from long-term innovation funding from the Higher Education Innovation Fund that has enabled institutions to make strategic plans. As well as enabling culture change, this government investment has bought a £3BN return to the UK economy and Universities[6]. There is nothing similar in Sweden yet. Who will continue to support any set of Principles once published? Who will seek out new initiatives and support "bottom up" schemes? Who will continue the work of the EFP? AT KTH there is a clear need for support of some type of planning and coordinating body, at least during the early stages transformation. Many other Universities face this issue suggesting this is something the funding and other government agencies must address. This point is returned to in more depth in the report's conclusions.

Stress the importance of student's active involvement

KTH should champion the vision that all its activities are creators of value for Faculty, students, and society. It is also instrumental to think in terms of demand for what KTH has to offer to prospective students and research partners. However, KTH must go against the tide and reject the notion that students are paying consumers of education. Engineering students, especially the ambitions and intelligent ones that KTH likes to attract, will not be impressed by being served knowledge, no matter how well organized. They want to be a part of the institution to as great an extent as possible. This is the mindset of a top international University, and of one that has a strong cultural capital.

[6] Julie Logan 2005; Unlocking Innovation in UK Universities: the Return on Investment made by the UK Government

KTH students should be educated and empowered to act as entrepreneurs in a wider sense. KTH should address the potential for engineering graduates to carry links to research and researchers with them into society. Both these activities would raise the value of the University in terms of the third mission.

Continue the development of links to Alumni

KTH's Alumni are working in the very industries that KTH wants to develop better contacts with. KTH has an Alumni team who have worked hard to create a list of alumni by graduating year and major with current address, and contact information. This task should be given priority. Each School should also consider developing a list of those alumni with links to their departments with any connections they may have. The Alumni team has produced an alumni-relations strategy including events, communications, and other clear "products" to stimulate engagement - as KTH cannot ask alumni for support without illustrating that it values the relationship first- and this activity should continue to receive support.

University-Stakeholder Relations

Introducing the theme

University-Stakeholder Relations refers to the multiple relations Universities have developed with already existing bodies such as companies and other organisations interested in research e.g. government agencies, the health service and trade unions. Whilst many universities address University-Industry relations, KTH considers it important to broaden the scope of this theme to include non-commercial organisations; these organisations also play an important role in KTH's activities and illustrate the commitment KTH has made to working with a wide range of social stakeholders. In championing this breadth of approach, KTH hopes it can make a contribution to how other universities perceive, and act on, their role in society.

This theme covers many activities. The provision of high-calibre recruits to both commercial and non-commercial organisations represent what is probably the most fundamental link between a University and society. Companies and other organisations also invest directly in University research – both of a collaborative and contract nature.[7] They may hire University researchers as consultants. Many universities are able to license patents or use other mechanisms for transferring technology. Many companies or organisations send their staff to universities for continued professional development, in both technical and managerial fields. Companies in particular may form philanthropic relations with a University too, donating resources or funds to ensure the development of research fields. Universities can also hire out either equipment or facilities and several universities host Science Parks, providing a base for local companies. Some companies and organisations simply value an "on campus" presence making use of seminars and other channels of communication to keep up to date with research fields and, more recently, spin-off activity.[8]

It is often the case that a single company or organisation will engage in several of these activities making it difficult, indeed unwise, to separate them out too decisively. A research project that engages PhD students, for example, is a useful way for a company to develop recruits with targeted skills and may also produce a portfolio of patents to be managed together with the University. Today such a project may involve multiple commercial and non-

[7] In a collaborative research relationship the research goal is developed jointly between the University and participating company and is of mutual interest. In a contract relationship the companies pays for a research project that it defines.
[8] Measuring Third Stream Activities, SPRU Science and Technology Research, April 2002

commercial partners e.g. in a VINNOVA Competence Centre (see below). For this reason KTH has chosen to address University Stakeholder Relations as a whole, rather than focus on specific aspects of this activity.

As the number and complexity of interactions between universities and stakeholders in society grows, it seems increasingly important to value *the relationship* between these bodies and a University, alongside its content. Many of the world's leading universities have invested in the professional management of relationships, in industrial fields at least, and KTH considered it wise to assess the benefits of this for its own development.

University-Stakeholder relations at KTH

As a dedicated Institute of Technology, KTH has always had close relationships with Swedish industry and has developed significant relationships with other organisations as these have grown. Today a full one third of Sweden's Engineers receive their education at KTH[9], these Engineers go on to make high level contributions to both Swedish and international organisations. KTH receives some 10% of its research funding from Swedish businesses and organisations, this funding often releasing further funds from either the Swedish funding agencies or the European Union, thus making it a key source of research income. Indeed, at least half of the sum of external grants to KTH research, approximately €M122, is committed to projects in which stakeholders are involved in the research process.

KTH is particularly proud of the long-term relations it has formed with leading Swedish industries such as Scania and Ericsson and has recently, for example, received a professorial Chair from Scania to ensure that research in transport continues to flourish over the coming years.

Relations between KTH and its stakeholders have tended to develop in an organic and embedded manner; various parts of the University have responded to different needs and opportunities. Today KTH has some relationship support service functions that operate on a corporate level. For example, KTH has a dedicated Careers Service to assist with recruitment. KTH's Executive School provides education for both large and small companies, and other organisations, in strategic and technical management skills (see text box below). Through its External Relations Office, KTH also provides a support service for Small and Medium sized companies as well as assistance with building other commissioned educational programmes. External Relations also manages research contracts and negotiations with stakeholders these may involve (see table below).

[9] KTH is Sweden's largest provider of Engineering graduates

University-Stakeholder Interaction	Corresponding KTH Function
Recruitment	KTH Careers Service
Research	Rector Competence Centre External Relations for SMEs Direct to academic
Consultancy and commissioned research	Direct to academic Engineering Institute
Technology Transfer	KTH Innovation Direct to academic
Commissioned Education	KTH Executive School External Relations Departments and schools
Philanthropy	No dedicated function
Use of facilities	No dedicated function

To date KTH has no dedicated "Office of Stakeholder Relations" or similar. Significant relations with large companies or organisations tend to be managed directly by the Rector or other senior academics. Smaller relationships are often the result of alumni contact with a professor or may come about through consultancy. VINNOVA Competence Centres (see Case Study XI) enable academics to work with a consortium of companies and organisations on a strategic research topic and have been highly successful.

The organic development of functions and services has lead to a diffuse structure for interactions at KTH. Whilst the working of the parts of this structure is positive, its overall loose organisation has made it difficult for KTH to make strategic, corporate decisions in this area – and, perhaps more significantly, for companies or organisations to understand and develop their interactions with the University.

Whilst KTH's overall income from stakeholders is good, there is potential for growth if comparability is to be kept with other leading technology universities.[10] As more research funding becomes allocated on a competitive basis that demands stakeholder engagement, it will become increasingly important for KTH to engage new stakeholders, as well as retain its positive relations with old. Indeed, as over half of KTH's research income is dependant on interactions with stakeholders, the handling of substantial relations with these parties must be given serious consideration.

Following on from this, KTH has fewer links with companies or organisations based outside of Sweden than is typical for a University of its standing. The global abilities and needs of Swedish companies and organisations, combined with the globalisation of R&D more generally, suggest this situation is not sustainable.

[10] MIT's **industry** income accounts for 11% of research income, Cambridge's for 17%.

CASE STUDY III:

Supporting industry through the KTH Executive School

KTH's Executive School was founded in February 2001 in direct response to a demand from Swedish industry for managers trained to take an overview of both strategic and technical developments in their companies. In October 2001 the School started its first Executive Programme, the tenth programme is now underway.

Training at KTH's Executive School combines both theory and practical applications in the business world; more than 300 different lecturers have participated in the School's programs, of which almost three quarters are managers and experts from industry. The remainder are Professors from KTH, as well as other universities in Sweden and abroad, ensuring the School provides a forum for the exchange of ideas.

How will new technology be introduced and the old removed? Will we integrate ahead and offer our customers full service? Is it possible to combine product renewal, variation and high service with low costs? Do we have to concentrate production in fewer factories, outsource it to low wage countries or have it closer to the customers? What can we do on our own, what can we buy from others? Can we find partnership and strategic alliances that will strengthen our position and drive profitability? These are just some of the questions that companies have addressed through the School. Leif Östling, CEO of Scania, comments, "Managers from Scania have attended all the programs and our experience is that the programs correspond to my *very high* expectations".

The issues

For a modern technical University, the issue of relations to stakeholders is more than an issue of "income from industry"; this is a question of relevance and partnership, both of which have wider implications. The University must be understood to lead a research agenda capable of powering industrial and social development, as well as pushing the frontiers of research. Further than that, the University must be known for providing up to date recruits and competent partnership. Relevance depends on knowledge of the world and engagement. Working with the best R&D companies and leading organisations, as well as providing income, will reinforce the University's skills and abilities, supporting it in maintaining its position. To achieve its goals, the entrepreneurial technical University must take its partnership and relations within these actors and networks as seriously as it does its research.[11]

[11] See Michael Gibbons "The New Production of Knowledge" for an in-depth exploration of the significance of networks in knowledge creation.

Strategic approaches to managing relations

Turning first to the role of strategic planning in relations, whilst it was clearly understood that the substance of a partnership, in most cases a research collaboration, is best managed between the academic concerned and research partner, several Universities also understood that the relations between the company or organisation and University require support and benefit from actively planned development. On several occasions KTH heard that it was critical to build "institution-to-institution relations", partnerships that can be developed successfully by both parties over long-term horizons.

At the University of Surrey, it was apparent that long-term planning with key partners from industry had enabled the University to grow research relations with organisations that were cutting back R&D elsewhere. The University of Cambridge manages some of its more important industry relations through Joint Steering Committees on which senior members of the company and the University sit. These committees plan the development of the relationship as a whole, constructing roadmaps that include educational and recruitment goals, for example, as well as research collaborations.

As well as managing current relations strategically, several of the technical Universities visited have also developed strategies for identifying and developing new partners for their researchers. Many of the most exciting companies or organisations with which a researcher might work are relative newcomers to the R&D stage – CISCO, Samsung, Vodafone. Several of the Universities visited had a capacity to monitor developments in the R&D industry, identifying exciting potential partners and actively seeking engagement with them – and educating them about the University R&D environment. MIT's Office of Industry Relations provided a particularly strong example of this.

KTH needs to ensure that it has a capacity to actively manage its key relations and the best and most exciting partners are identified and engaged for its researchers.

The devil in the details

While KTH believes that the characteristics described above are the overarching priorities for a University with ambitions to develop stronger relations to stakeholders, the University cannot fail to recognize the importance of the terms under which the competencies of the University are offered. Terms for ownership of intellectual property (IP) created in academic institutions is an obvious example that has received a lot of attention in contemporary debate. It should be noted that Swedish legislation, where researchers by default are guaranteed the right to all IP they create, is something of an international exception. Terms for joint venture research are also set by the overhead costs that the University extracts from partners in contracting. Since a large portion of research is performed by PhD candidates, the

typical cost for a student salary also influences the attractiveness of maintaining professional relations to a University. Preliminary findings from this project suggest that these costs differ dramatically between countries. Again, Sweden seems to be the exception, distinguished by high costs. These terms must be reviewed more closely, especially since they influence a University's ability to maintain relations to small and medium sized companies.

From arm's length to shared facilities

Strong relations to industry is a hallmark of technical Universities. In earlier times usually manifested as cooperation between clearly separated organisational bodies, these links are nowadays manifested in new ways. It has become common to establish joint organizations, manifesting an intention from all participating parts to enduring cooperation. Physical closeness between a University and its partners is also a recurrent theme. Intended to build bridges between entrepreneurship and academic research, science parks and incubators are often located close to University facilities. But commercial interests and applied research in the business sense of the word are also finding their way into the heart of technical Universities, as non-academic operations (firms, public research institutes) are co-localised with University activities. Joint-staffing and jointly used facilities are common reasons for, and common outcomes of, such arrangements. The academically well renowned MESA+ institute of the University Twente is a clear example of how a University can benefit from such contacts, being able to afford better equipment and laboratories through facility sharing and maintaining a natural link to on-going commercialization processes.

Intermediating organisations

Difference in cultures and in organizational rationales are often cited as major hinders for strengthened links between Universities and their stakeholders. Among the responses to such insights is the strengthening of intermediating organizations and the creation of hybrid organizations. While in Twente, the delegation had the opportunity to meet representatives for one of the four Dutch public research institutes founded in 1996, in an initiative aimed at clustering and supporting research in areas particularly important to Dutch future economic competitiveness. These institutes are located close to the technical Universities, allowing them to play a connecting role between firms and Universities – both in personnel unions and in research cooperation. Discussion with representatives in Switzerland made clear that the country is attempting to follow the Dutch example. Although the Swedish institute sector is relatively small, KTH is well equipped with research industry partners, as 10 independent institutes are located at KTH campuses.

How can KTH address this theme?

Serious about serious relationships

At the Universities visited, KTH Faculty were impressed by the seriousness in the approach to industry relations finding it both strategic and professional. Within the offices visited, less emphasis was placed on broader stakeholder relations; however, it was considered that many of the lessons learned in industry relations might be positively transferred to a broader set of partners.

Professionally developed relations

Vital in enabling strategic industry relations at the Universities visited were dedicated teams of professionals in this area – actively supported by senior Faculty. Cambridge, EPFL, MIT and Surrey (and now Stanford) have dedicated central offices that seek and actively develop industry relations on behalf of their Universities. At Twente and Delft, KTH saw Centres or Institutions with a member of staff employed specifically to develop industry links.

Feedback from KTH's April Seminar

"Dance Floors" and Central Support; the University of Cambridge's approach to managing relations with stakeholders

Whilst the University of Cambridge considers it vital that its researchers are free to pursue their own links with partners, as a corporate entity it recognizes that it must support this activity by building "institution-to-institution" links. Dr Christopher Padfield, Director of Strategy for the University, described to the KTH audience how Cambridge has established "a variety of dance floors and facilitation mechanisms to promote engagement, maintain networks" with the aim of optimizing the University's impact in the world. The University has, for example, established a research seminar series called Horizon at which it showcases emerging areas of research in front of an industry and non-commercial audience. It also has a Corporate Liaison Programme that ensures companies have a clear point of contact within the University through being assigned a Business Development Manager. Like dance floors, Cambridge's services and events for its partners should be exciting and attractive – promoting the social interactions that underpin all sustainable relationships.

A reflection of the serious attention Cambridge now gives to its relationships with stakeholders can be seen in its creation of the Partnership Group in 2005. This centralized unit brings the offices of the University that a company is most likely to encounter together under *one clear brand and management*. As well as making it simpler for companies to work with the University, it is hoped that this structure will create internal synergies, in particular the University will be able to understand better the scale and scope of relations it has with specific companies.

Where does relationship management belong at a University?

KTH already has professional industry relationship managers employed by a handful of Centres e.g. the Engineering Institute and KTH Wireless; as yet KTH has no central capacity. Government and other non-commercial relationships are also devolved to a variety of offices. Considering the increasingly multi-disciplinary nature of research and the many ways in which a University can interact with multiple stakeholders, a central team would seem to be an asset able to look at relationships as a whole and able to support KTH in placing its relations on a strategic level (see above). It is recommended, therefore, that KTH form a team to address what a successful Stakeholder Relations function would look like within the University.

To ensure that any such office serves the academic community fully, it would be critical for this central team to interact with KTH's Schools and Centres. It would be exciting if this interaction could be planned into KTH's "Office of Stakeholder Relations" from the start. It is possible to envisage a corporate relations team from which individuals are seconded out to assist in the formation and smooth running of centres or other initiatives both making use of and replenishing the central resources.

Need this unit, however, be part of the Central Administration? The ETH Foundation at Zurich has been "spun-off" from the central University and is run much like a wholly-owned company with the task of raising funds for ETH Zurich. This was seen as highly positive for the culture and working practices of the Foundation; it was able to pursue goals and targets in a manner that is atypical within a traditional University administration culture. Whilst the ETH Foundation is specifically concerned with fundraising from industry, could KTH consider structuring its relationship management office to provide similar benefits? Should Stakeholder Relations be a separate entity at KTH? How, though, are we to ensure that such an office stays close to the core values of the University and properly serves the Schools? These are interesting questions for KTH to resolve.

New Support Systems for Entrepreneurship and Innovation

Introducing the theme

As well as supporting "up-stream" stakeholder relations, many Universities play active roles "down stream", assisting Faculty and students to ensure that the outcomes of their research projects are transferred to society either through licensing agreements or the formation of new companies.

CASE STUDY IV

Feeding the innovation stream – the MIT Deshpande Center

Whilst MIT is synonymous with entrepreneurship and academic excellence, its a surprisingly small percentage of MIT Faculty who actively patent research or develop the commercial potential of their inventions. The Deshpande Center was launched in 2002 following a donation of $20 million from Jaishree Deshpande and Desh Deshpande, the co-founder and chairman of Sycamore Networks Inc., to promote the commercialisation of research within the School of Engineering through enabling early-stage explorations of the commercial potential of research.

Krisztina Holly, Director of the Centre and an MIT Entrepreneur herself, has guided the Centre's Innovation Grant programme to focus "great research", ideas very much still on the bench that have an exciting glimmer of commercial potential. The grants of between $50k-250k enable scientists to explore different markets for their concepts and develop market-specific prototypes.

As Krisztina is quick to stress, the project is equally about familiarising the researcher with MIT's rich entrepreneurs' support network as it is about providing funding and much of her time is spent introducing researchers to technology transfer professionals, venture capitalists or other key players in the "MIT Ecosystem". The Deshpande also sponsors educational workshops for MIT Faculty addressing, for example, the balance between an academic career and entrepreneurial interests, intellectual property issues, or conflicts of interest. This is long-term work but by supporting a culture as well as companies the Deshpande Center intends to be around to see the results of its labours.

Support systems at KTH

KTH, together with various funding agencies, has invested in innovation activities steadily over the past decade meaning credible capacity has been built and notable achievements made. Through KTH Innovation, KTH is working hard to ensure that entrepreneurial behaviour is spread across campus. KTH Innovation, a part of the External Relations Office, is tasked to:

"Inspire and Stimulate, Proactively search for and Identify, Verify and Develop, results and innovations from KTH's students and scientists". KTH Innovation also supports the teaching of entrepreneurial skills through a collaboration with Stockholm School of Entrepreneurship (SSES), and by participating as an active partner in the business plan competition "Venture Cup".

Together with the student run entrepreneurship association, Excitera, KTH Innovation has developed a second annual competition, the Excitera Innovation Challenge (EIC). This novel competition brings together interesting results and innovations from KTH's scientists with entrepreneurial students and aims at finding new application areas for cutting edge technologies.

Through KTH Holding AB, a fully owned subsidiary to KTH, the University can take equity in spin-offs. However, the holding company structure in Sweden is currently under review and the Swedish government will, during the autumn of 2005, appoint a central negotiator who will investigate the structure and suggest a proposal for the future.

KTH has also recently signed a joint venture agreement with Stockholm Innovation & Growth, (STING), to support the further development of innovation support for start-ups that stem from KTH. STING provides a world-class support environment for entrepreneurs and spin-offs from across Stockholm (see text box).

Assisting access to funding

Within KTH's support system there are several players who provide seed money for startups that originate primarily from KTH. There are three important players: the Kista Investment Network – a network of approximately 20 business angels; STING Capital AB – a small, unique venture capital fund focusing on pre-seed investments; and KTH Seed Capital KB - a 127 MSEK venture capital fund investing in leading technology start-ups from both KTH and others origins. There is, however, a lack of substantial early "pre-seed verification" money on the same terms as, for example the "Deshpande Center" at MIT provides (see comments below).

CASE STUDY V

Delivering Innovation with a STING at KTH

Having developed a successful formula for promoting spin-off activity from research at its ITC Campus in Kista, KTH recently announced its intention to expand the KIG spin-off programme by supporting the formation of *STING*, Stockholm Innovation and Growth. STING is open to take budding technology entrepreneurs from across KTH though a challenging programme of training to help them develop robust business plans. Its Business Lab and Business Accelerator programmes will help fledging companies roll out their plans, with mentor and other support. In return STING will take special share options that, should the company become profitable, will give it a cash reward.

Notably, STING has announced the foundation of STING Capital. This new Venture Capital company will initially have 22MSEK of funds to invest in exciting new enterprises and has been established to focus on very early pre-customer and pre-product funding, an area where, historically in Sweden, it has been difficult to find funding. STING Capital's funds come from a mixture of public and private sources and it is intended that this blend of financing will expose young companies to a broad support network, this being useful in supporting their long-term growth. With its close links to the STING programme and KTH campus, STING Capital hopes it will be able to raise further funding from investors keen to get early access to the brightest new companies coming out of research.

The issues

Verification funding: helping to "de-risk" start ups

Whilst any new venture that seeks to have impact must face uncertainty, a University can play a positive role in helping its researchers and students address this. Pre-seed research funding, such as the Deshpande Centre at MIT provides gives both time and money to a research group, enabling it to explore the commercial potential of its plans before embarking on the new company route. Some Universities are fortunate enough to have associations with substantial funds for pre-seed research funding, others are considering how it might approach stakeholders such as alumni to fund such an initiative. Other support is also possible; in the UK several research grants include an invitation for application for monies to explore commercialisation possibilities directly (a PhD student, for example, can be kept on for an extra year). KTH encourages Swedish agencies to support similar schemes.

There is a clear need in the Swedish context also to improve access to early stage venture capital. Government assistance is necessary here as "Angel" style investments, which are crucial in many countries for developing initial ideas, are only just emerging. The success of Venture Capital Trusts in UK provides an interesting example of how this area might be tackled. These publicly subscribed trusts, which pool investor cash to invest in small and

medium size firms, are accompanied by tax breaks meaning that investors in the trusts receive an upfront 40% tax relief. The Trusts have proved enormously popular with over £400 million being invested in 2003-04 alone. Do these Trusts play an important social role too, interesting the public in knowledge transfer and new enterprises?

Need up-stream and down-stream innovation activities be separated?

University Innovation Systems have become polarized by talk of up stream (industry relations) and down stream (start-up and technology transfer) activities. Is this a useful divide? Start-up companies seek large companies as customers; large companies seek innovation through working with start-ups. Indeed it is often more appropriate for a new technology to be licensed to an existing company than for a new company to be formed, as was discovered at MIT where only 10% of licenses go in to new companies.

Feedback from the April Seminar:

EPFL, championing a Parallel Approach to Innovation Support

Innovation, by its very nature, seldom appears on demand! This was the point Jan Anders Månson, Vice Rector for the Third Mission at Ecole Polytechnique Fédérale de Lausanne (EPFL), and Hervé Lebret, Industrial Relations Officer at EPFL, stressed to the KTH audience. Innovation support systems, therefore, must be designed to respond to needs in a parallel rather than lineal manner.

Professor Månson noted that all too often Universities considered Intellectual Property, or other commercial applications, as the *end product* of research by senior researchers, where as in fact, actionable ideas could emerge at any time during a research project and could come from any member of a team. Entrepreneurial education and support programmes should be designed with the non-lineal nature of innovation in mind. EPFL has designed 10 programmes that support the innovation chain, which importantly, can be accessed in any order so that the right support can be given at the right level and moment. This is what they call their Parallel approach.

Notably, EPFL are also taking continuity of support seriously. They found that researchers were frustrated at having to apply to different funds and organisations as their ideas progressed towards commercialisation. Indeed, some researchers, fatigued by having to continually reapply for support, abandoned the commercialisation of ideas with substantial potential. EPFL, therefore, has constructed a “one-stop-shop” model within which researchers have a single point of contact and progress without reapplication – though, of course, with regular assessments of how the idea is progressing. This simplification has been popular amongst researchers and has increased the speed of ideas to market.

How can KTH address this theme?

Professionalizing support for technology transfer and entrepreneurial activities

As with industry relations, KTH benefits from the support of a few key individuals in its technology transfer and start-up activities. Again, it is vital that the skills of these people are understood, made use of and valued. KTH cannot expect its entire Faculty to excel at industry relations, starting companies, research and education! It wants to continue to invest in professional support in this area and is frustrated by a continued lack of clear funding for serious and sustained efforts in either industry relations, technology transfer or entrepreneurship.

With regard to the development of these staff, in both the US and the UK, professional organisations have been established to accredit and represent knowledge transfer executives. KTH would like access to a similar organisation for its staff and wants to support the community formed through the EFP in continued bench learning in this area.

Whilst KTH would like to see more funds available for the recruitment of such professionals in general – see comments above and below – experiences in the US in particular suggest that substantial gains in this area can be got from exploiting alumni networks, alongside professional support. KTH has already begun exploring Venture Mentoring with its alumni community and wants to give this higher priority over the coming years. Perhaps also alumni considering starting a company could be invited back to sit in relevant KTH research groups, following the Twente TOPs Programme, or its incubator facility?

Identifying funding to sustain growth

To be able to expand and improve support for the innovation system at KTH there is a need for more, and more secure resources; both for the development of a truly professional organisation, with experienced tech transfer personnel, and for specific activities, as mentioned further verification funding is required. These resources should come both from a budget increase for these activities *from KTH* and external funds, such as are provided by VINNOVA and other agencies at the national and regional levels.

Whilst appreciating the impact of external funding, it is important that KTH also work to set up clear income streams from the investments made. Today KTH has three main income streams from its investments; equity in spin-offs through KTH Holding AB; revenues from KTH Seed Capital and STING Capital; and exit revenues from STING projects that stem from KTH. However, these income streams are very low currently and, as is now

well evidenced internationally, healthy income streams from these types of investments cannot be expected speedily. Whilst work to produce income streams actively continues, support funding must come from elsewhere.

Develop synergies at a central level

Whilst the skills and activities in industry relations, entrepreneurship support and technology transfer are distinct, it seems obvious to KTH that there are considerable and valuable synergies between these fields which it should move to benefit from. The University of Surrey had combined these functions in what appeared to be a beneficial manner. Co-location of these different functions on the KTH campus, as a start, would provide good levels of informal interaction and steps have already been taken in this direction.

Alliances – Regional, National and International

Introducing the theme

Working together is a permanent feature of academic tradition. A relatively new development, and one that seems to be growing, is high-level, formalized relations between Universities. Each and every one of the eight visited Universities is, just as KTH, involved in a formal alliance.

The main benefits for Universities within Alliances seem to be opportunities for synergies in teaching, research and cooperation alongside developing brand awareness, profiling and differentiation. In this respect, there are significant potentials in forming relationships. So far there are no indications that alliances have or are about to result in any major "rationalisation benefits", the traditional benefits of scale business seeks from its alliances. Within the scope of this project, KTH wanted to explore the impact of alliances on innovation and relationship development activities. Can the formation of an alliance, for example, be a tool for an entrepreneurial University? Can an alliance increase the attractiveness of the University for global industry and other international sources of funding?

CASE STUDY VI

Three Dutch technical universities to unite in federation

Given the relatively short geographical distances between them – no more than two hours drive – close cooperation between Holland's three technical universities, Eindhoven, Delft and Twente, is not surprising. In March 2004 plans to take cooperation further and create a single "Federatieve Technische Universiteit Nederland" by 2010 were made official. Joint plans for education, research, and innovation management have already been outlined and the universities have committed to directing 12 to 15 percent of the funding received from the Dutch state for joint research priorities in the period until 2010. As well as promoting large-scale joint research projects, in practice the alliance has also permitted the Universities to specialise. Twente has decided to focus on developing its profile in nanotechnology at the expense of other research areas better represented elsewhere within the alliance.

In September 2004, cooperation in innovation management and out-reach was organised in the form of the "3TU Innovation Lab" and each University has committed one full-time employee to the organisation. Working groups have been put together with the mission of identifying "best practise" in innovation management among the three TU:s and discussing the harmonization of activities. One example of this is the TOP-programme at UT (see above), which is now implemented on a national level. Other areas that the 3TU lab has started discussing include the coordination of incubators – developing thematic distinctions between incubators at the three TUs - and a joint IPR structure. Targets for the Federative University include increasing academic patenting by a third and, through scale and synergies, increasing the flow of international funds by 20 percent.

The alliance is proceeding with caution however; Mr van Luijk of Delft University, who chairs the board of the 3TU steering committee, emphasises a need to preserve the respective brands of the universities. It was also clear that TU Delft was not willing to let 3TU-cooperation crowd out important cooperation with other local actors in the higher education system, the strategically important cooperation with the University of Leiden or its membership of the European IDEA League.

Alliances at KTH

KTH's formal alliance with the second largest technical University in Sweden, Chalmers in Gothenburg, was launched in late 2004. KTH also has strong connections to its neighbouring Universities, formalised in a large number of projects. Academically, there are particularly strong ties to the Karolinska Institute, Europe's top-ranked medical research institution, and Stockholm University. The Stockholm Academic Forum is a body where recruitment for basic education and establishment of university-industry relations are promoted by Stockholm Universities in cooperation. The SUSAM alliance is a forum for six Universities in the wider Stockholm-Uppsala region. KTH is also a member of the CLUSTER alliance – an example of pan-European cooperation.

Reviewing the alliances found at visits, and studying some other examples in the rich and growing flora of University alliance projects, it is clear that these projects arise from different needs, have different purposes are designed in fundamentally different ways. On the one hand, there are "soft" factors: alliances can be a way to organize organisational learning and development, to achieve branding effects or to create cultural exchanges which affect academic cultures. On the other hand, there are a number of "hard" goals of some alliances: coordination to achieve improved student and staff mobility, combination of strengths to gain critical mass in research and education or ambitions to increase efficiency of operations. To be able to benefit from the alliances of which it is a part, KTH needs to formulate

expectations on each of these relations and continuously make judgements of which relationships the University needs to develop.

The issues

Coordination of third stream support functions

As noted above, the Dutch Technical University alliance includes a working group that seeks to coordinate and advance activities in knowledge transfer. The group has initially focused on harmonizing IPR regulations and coordination of incubator programmes. The i10 group in the East of England provides another example of coordination between such activities. The group has, for example, compiled an inventory of different types of equipment available at the different Universities in the region thereby providing an easily accessible database for industry partners. The i10 group also runs a consultancy service for all ten Universities meaning that a company can direct an enquiry to a single point, having it answered by the best placed University. The Innovation Bridge in Stockholm has done much work to assist KTH in developing its regional services and it is hoped that experiences from the travel visits can be used to seed further project.

Branding, profiling, bench learning

The two most geographically widespread alliances studied – the Cambridge-MIT Institute (CMI) and the IDEA League – seems to have several ideas in common, such as facilitation of student and Faculty mobility, coordination of educational offers and creation of joint courses and high-level bench learning. Behind the rationale of both alliances there is also a strong hope to attract further funding through synergies of strength and through branding effects. The IDEA League and CMI alliances are both formed by well-established Universities with strong brand names. By emphasising cooperation with high-profiled partners, they can be said to make their respective brand even stronger, in the long term adding to their "world class" image.

Image and brand is indeed gaining importance for Universities. Even more importantly, research excellence, the traditional benchmark of a research University, is becoming increasingly important as international competition and mobility gain in significance. This is especially true in research cooperation with large, global companies and in competition for international research funding.

CASE STUDY VII

Alliance of the titans

"In the late nineties, British Chancellor of the Exchequer, Hon Gordon Brown, went to Cape Cod for vacation. Having some time off, the minister found time to read the Bank of Boston report about the economic impact of the Massachusetts Institute of Technology (MIT). The report indicated that MIT graduates successfully transferred their knowledge into businesses by setting up more than 4,000 firms that generated significant income to the US economy and created more than 1.1 million jobs worldwide. Gordon Brown returned from vacation determined that his country must learn from the successful Americans. He went about the creation of a cooperative project between a British University and MIT, offering financial and political assistance from the government. His trial balloon soon bounced back over the Atlantic with a clear message: 'ok, but its 50 million dollar and Cambridge, or nothing.'"

The story is told with great enthusiasm by Prof Michael Kelly, executive director of the Cambridge-MIT institute (CMI). The institute has been active since November 1999, and Michael Kelly is convinced that there is nothing like it anywhere else.

"Unique, he says, is the only possible description of CMI".

The Institute is established for a six-year period, but an application for funding for an additional five year period is already underway. All CMI projects are jointly undertaken by Cambridge and MIT and each University receives roughly 50% of the funding. At this time CMI has over 60 ongoing or completed projects. Its various activities are supported by structured processes for "knowledge exchange" and "knowledge transfer" between the universities, other research institutions, business and the wider community. This has included the involvement of entrepreneurs and investors who are helping to transform innovations into commercial applications.

The UK government from the beginning stated that CMI was to "think the unthinkable" to generate ideas for the application of research in business and industry to substantially benefit the UK economy in a long-term perspective. CMI is therefore expected to take risks by funding experimental projects. CMI's activities also include research projects and educational programmes that focus on how best to guarantee effective knowledge exchange. There are also comprehensive undergraduate, postgraduate and research programmes.

By allowing students and researchers to work side-by-side with colleagues from one of the most notoriously entrepreneurial universities of the world, the CMI sees itself as doing more than creating structures, technology and experiences.

— An important long-term ambition of the CMI is to change UK University culture, says director Michael Kelly. If such an ambition is fulfilled, the alliance has truly fulfilled its role as a bridge to the future for British universities.

Strength through focus?

The described Universities are all believed to be strong in research, and may hope to achieve and maintain excellence in their existing structures and co-operations. The contribution to research excellence of an alliance may then be seen as that of facilitating increased mobility of Faculty and intensified cooperation. One important point of departure for the CMI alliance is that innovative ideas arise when researchers at leading institutions work together and exchange and develop ideas.

A somewhat different approach can be found at the Dutch University in Twente. To build excellence without increasing the size of the University in a significant way, the University feels that it has to concentrate its operations. By closing down activities, the University discusses reducing the number of scientific fields that it is active in, down towards three areas. Such concentration does, however, imply a great risk. In Twente, the alliance with the sister Universities in Eindhoven and Delft is seen as a way to handle that risk.

Creating a common voice

One of the common views on the 3TU alliance project seen in Holland was that the cooperation would allow the three technical Universities to speak up to the government in a more cohesive and thereby influential way. A similar view was found in Surrey, regarding the increased demand for evaluation by the government: "Being a large consortium allows us to speak up to HEFCE[12] regarding what should be measured and how to measure that, thus shaping the way we are being assessed."

How can KTH address this theme?

Address innovation issues in partnerships with other Universities

In its alliance with Chalmers, KTH should seek to address innovation and relationship development issues finding opportunities for mutual learning and harmonisation. The i10 example in particular illustrates what practical steps can be taken to make an alliance function for the benefit of local industry. KTH wishes to start a working group with Chalmers in this area.

[12] HEFCE is the Higher Education Founding Council of England, the government agency responsible for distributing government funding to higher education institutions in England.

KTH already operates with its partners in Stockholm on the entrepreneurship agenda; the Stockholm School of Entrepreneurship is a clear example of this. There is substantial potential to coordinate initiatives on industry relations too as Stockholm's Universities directly complement each other in terms of research profiles making the city's Universities *as a whole* an exciting partner for industry. In proper time, could a single Corporate Relations function be set up for the three Universities?

Use alliances as branding instruments

KTH's alliance with Chalmers undoubtedly raises the profile of both Universities. Again there is massive scope to work with the other Stockholm Universities, marketing the Stockholm area as a "knowledge city". Plans are underway for KTH, together with other Universities, to develop a report, somewhat like the "Engines of Economic Growth" report issued by the eight Universities in the Boston area that will illustrate the impact of the Universities on the region and suggest further routes for collaboration.

What about the potential of Scandinavia as a region within Europe? Sweden's regional partners have exciting and complementary strengths in their innovation activities. Finland, for example, is highly skilled in technology transfer activities. There would seem to be strong opportunities for KTH to benefit from these already established links. Establishing an active working group to explore these links for KTH would seem like a positive investment of resources.

Put alliances on the strategic agenda

KTH has to clearly communicate different views and initiate a discussion among Faculty about which of the above-described benefits it hopes to win from its alliances. Special attention has to be given to the emerging alliance with Chalmers and what the road ahead looks like from a Faculty perspective. The underlying principle for these discussions must be that the alliance is to be formed in response KTH's and Chalmer's own strategies. Major results will be of a long-term character, so long-term strategies are called for. However, as the field is not exploited so far, short-term effects can be also be anticipated. An obvious first candidate area for this alliance is the advanced level within the educational system of the Bologna process.

Communication and Branding

Introducing the theme

Communication is, perhaps, the "accidental theme" of the six KTH has worked with. It was not in the initial project brief but, as visits progressed, it became clear that this was an area and activity that several Universities were extending efforts in. Also, whilst cautious of the criteria used, a break down of KTH's scores in "University Rankings" shows KTH scores badly in peer reviews, with fellow academics not ranking the University highly. This is disappointing in particular because, as these rankings also show, KTH produces good research, indeed its research impact (cited papers per member of Faculty employed) is *as high as* that of Cambridge. It seems that KTH fails to communicate the quality of its research sufficiently within academic circles, let alone in the broader environment.[13] Whilst the current international ranking systems used have flaws, KTH's performance in them matters because they affect international recruitment and staff retention.

Critical in enabling innovation and out-reach, it seems, are actions that communicate a University's commitment to these types of initiatives to the world outside academe. The function of any initiatives depends upon informing and attracting partners; therefore, active communication is essential. Equally important is effective management of internal communications – vital to build and reinforce University culture. Communication, it seems, is the infrastructure of the knowledge economy, giving it substance and linking its multiple actors together.

[13] Information taken from the Times Higher Education University Rankings 2004.

CASE STUDY VIII

Letting the world know where you are – and where you want to go: ETH Zurich's active strategy for communication and branding

ETH Zurich has a remarkably active profile in the area of communication and public relations. Its Corporate Communications division employs 40 people, corresponding to 25 full time staff. Through this department, ETH runs one of the most ambitious web magazine projects to be found at a European University. Since the launch of *ETH Life in* 2001, the editorial office, consisting of seven journalists, have published news, portraits, debates, articles and so forth, all with clear focus on current activities at the ETH Zurich. ETH Life is also available in an international, English language edition. Both editions are updated on a daily basis. As one researcher remarked, "the web magazine is how I know what my colleagues are doing – it's good to know that I'm part of such an interesting place!"

Corporate Communications is on 24 hour call and sets itself tough targets for coverage in the Swiss and international press; for example they expect ETH to be mentioned in the international press at least 6 times a week. The office also runs a personnel database that lists the research interests and teaching responsibilities of each Faculty member.

Only ten-fifteen years ago, the mission of universities when it came to communication was "inform the public about research results". That is still a very important mission, but current developments put greater demands on universities. To stand strong in increasing competition, a University is more than ever before forced to manage its brand successfully. At ETH Zurich, the importance of the University brand for relations to funders (perhaps most importantly, Swiss tax payers and politicians), industry, potential students, alumni and, not the least, ETH Faculty is clearly recognised. Director of Corporate Communications Rolf Probala explains:

"In everything we do, we always communicate the same message: that the ETH Zurich is a leading technical University at the heart of Europe, addressing some of the most important challenges in the modern society. To the general public, we wish to communicate the importance of ETH to society, to potential industry partners, that ETH is a magnet for excellence and a powerful partner, to alumni, that ETH is a strong partner for professional development, and so forth."

Communication at KTH

KTH's Public Relations Office has a staff of 11. The office produces material for the central webpage and a number of printed publications, manages KTH's corporate profile and has a supportive function for KTH schools and researchers. Recently, a new industry-focused magazine, *KTH&Co,* was introduced. The magazine is to provide insight into KTH research for existing and potential corporate partners, and in particular KTH alumni. The Public Relations Office also supports media with information about development at KTH. A weekly collection of press content concerning KTH is produced by the unit *Info-Center*.

CASE STUDY IX

Clear conception of receiving audience

KTH's own magazine *KTH-Nytt* was a well established channel for communication with staff, Faculty, interested alumni and virtually anybody else interested in keeping in touch with the University. But at the public relations office, concerns were raised that these groups of people were just too diverse for the magazine to appeal to any of the groups in an effective way. A first step in addressing this was the launch of a new magazine dedicated to the communication with staff and Faculty in 2002. In discussions with the Vice Rector for cooperation with business, industry and society, a plan for more effective communication towards the business community was made and in 2005, KTH-Nytt was replaced by *KTH&Co*. The public relations office sees two main channels for the new magazine: direct distribution to selected firms and KTH alumni. The office has identified a large number of firms in the Stockholm-Mälar region as potentially interested, all of whom will receive the magazine for free. Editor Håkan Soold explains the philosophy behind this venture:

"We wish to present KTH as a University keen on cooperation, and show examples of interesting projects where industry and University work together. Naturally, we also wish to inform about how central KTH contacts can assist potential partners in establishing cooperation."

The new magazine shall communicate the message that KTH is a leading, dynamic technical institution and reflect recent and continuing changes in the University environment. With a clear view of who the receiver of these messages are, KTH's new communication initiative may be able to communicate KTH's values in a more efficient way than previous publications.

The issues

Giving industry something to talk about

Communications that targeted industry were at the forefront industry relations initiatives at many of the Universities visited. Sometimes corporate relations offices ran the bulk of industry-focused communication initiatives, as at Cambridge, sometimes, they were part of wider press plans developed by a central press function, as at ETH Zurich and MIT. Regardless of where exactly they were run from, these initiatives provided a window on University activities for potential corporate partners – as well as, of course, the University's own staff and other actors.

Cambridge, TU Delft, Stanford, Surrey and MIT run themed, multi-disciplinary research seminars for partners from industry on a regular basis. MIT runs nine of these events a year, ensuring they address industry critical topics such as bio-therapeutics, energy, IT innovations and future economic strategy. A positive "side effect" of these seminars, commentators from

Cambridge noted, was that they seeded multi-disciplinary research collaborations *within* the University, as well as between the University and its partners

Sharing knowledge

Comprehensive, web-searchable databases were also a feature of Universities with strong communication strategies. Again, MIT and ETH Zurich stand out as having particularly well designed and frequently updated databases that provide a clear resource for industry and internal audiences, signalling which researchers work in which fields. Notably, MIT's research database is internal and only available to (paying) members of its Industrial Liaison Programme. KTH's own comprehensive research database "KTH in your Pocket" is available online and is a useful resource.

How can KTH address this theme?

Introducing seminars series

As KTH evolves its School organisational model there is a clear need to ensure that across campus communication continues so that areas of common interest can be identified and multi-disciplinary research project seeded. It seems that a research-seminar series, along the lines described above, that drew on the breadth of KTH research would serve both KTH's internal and external audiences.

Sharing knowledge

The existing project database *KTH in your pocket* could be updated to include more personal information about researchers, functioning as a tool through which industry, and other partners, could seek consultancy with individuals. It could also be used to provide leads to the press office on new research projects; it already lists projects of current interest. KTH should also support work in this area run by partners such as Stockholm City and Stockholm Academic Forum.

Information and Culture

Of course, there is a substantial overlap between good communications and the development of a thriving internal culture. In promoting an innovative culture in which relationship building is valued, KTH could make better use of the channels it already has available, as well as exploring new.

In coordination with the Public Relations Office at KTH, the project suggests that a team is formed to actively consider communications in innovation and relationship development. An Events Diary could be added to

KTH's intranet allowing individuals and groups to publicise their activities better. KTH could also provide real-time information on its innovation successes to the community, for example, constantly updating graphs illustrating how many companies had been founded, technologies licensed or research collaborations signed. Blogging is also developing as a vital channel of communication in many organisations and, as a highly IT focused University, KTH should explore what it can achieve in this field.

Management, Organisation and Funding of Innovative Initiatives

The project investigated initiatives, schemes and good practise at a number of entrepreneurial Universities. To fully understand the concept of entrepreneurial Universities, one must also consider how innovation initiatives within these Universities are managed, organised and funded overall. Indeed, the general management, organisation and funding of Universities cannot be neglected as these structures decisively effect what is possible in terms of innovation and how initiatives can be run successfully. This section will consider the general management of Universities with regard to promoting innovative activities

The issues

More management – threat or promise?

The demand for modern management and comprehensive strategies in Universities is a fairly recent development and one that has been brought into focus by the demands now placed on universities to develop and manage third mission activities. Universities, it seems, are increasingly ambitious in developing strategies and plans for the future. It is not, however, a straightforward task to implement strategies in a University environment. Collegiality is a principle deeply embedded in the "soul" of the universities, and one can ask not only what powers University management should have, to avoid compromising collegiality beyond what's healthy for a research University, but also what powers they can be given.

It is a fairly unprovocative statement to say that strategies must be adapted to the means available. But when comparing the financial and legal means available to the visited universities with those of KTH[14], a critical question arises. Does the Swedish system for higher education and research allow universities to develop strategic abilities? If the answer is doubtful, KTH and other ambitious Swedish universities might be up against impossible odds in the global competition.

[14] See Appendix X for details.

CASE STUDY X

A strategic leap into a new field – the Brain and Mind Institute of Lausanne

As globalisation grows stronger, competition among universities for staff, students and resources is increasing. This message echoed through all the visits made by the Swedish delegation, and, indeed, acted as a starting point for the Entrepreneurial Faculty Project itself. So, how does one address competition and attract the attention of the best researchers, industry partners and students? The answer found at every University, School or research group visited during KTH's study journeys was "by building excellence!"

Leading universities are able to identify the right opportunities for their Faculty and act to fulfil these opportunities at the highest standards of international excellence. An interesting example of such behaviour is the creation of the Brain and Mind Institute (BMI) in EPFL Lausanne. Recognising the vast futuristic possibilities of exploring the functions of the human brain and the possibility to draw on existing related research, EPFL decided to invest in the creation of a multidisciplinary centre. Professor Henry Markram, a leading scientist in this field, was given an offer that persuaded him to abandon a planned move to MIT and become director of the institute.

"I was convinced by the strong vision of the EPFL president, Professor Patrick Aebischer," reports Henry Markram, "He was committed to building a strong institute and a Faculty that could draw on the most powerful technological positions of EPFL and give the University a new high-profile area. Also, I must admit that I was attracted by the possibility to take long walks in the Alps…"

The BMI has been constructed as a network of 18 closely related laboratories and more than 200 researchers. The comprehensive goal of the institute is to explore the emergence of higher brain functions. The BMI claims to have "multiple initiatives to develop new technologies ranging from the use of nano/microtechnologies to virtual reality to explore brain function and to apply neuroscientific knowledge to develop applications and therapies."

EPFL invested substantially in recruitment and first class laboratory equipment; other areas had to give up funding, or even buildings. The decision was not altogether popular with the remaining Faculty.

"But today, we are regarded with more keen eyes by the engineers", says Professor Markram, "You see, by building a competitive position, we are beginning to attract funding for them too. Powerful competence is a magnet for large funding, both from industry and from official sources. What's more, it is a magnet for competent staff, the brightest students and journalists".

Organisation – the difficult balance

When studying the entrepreneurial abilities of Universities, the issue of organisation arises again and again. Traditionally, universities are decentral-

ised organisations, emphasising the independence of faculties, institutions, research groups and professors in relation to the organisation as a whole. As new roles have been assigned to the University and financial pressure have increased, there are however clear signs that many Universities have responded by building stronger central organisations. Does the University need to model its organisation more in the fashion of a corporation in order to release its entrepreneurial potential?

An obvious response is that a University can not, and should not, be modelled after corporate design, as it runs the risk of losing its very "soul" and dampen the freedom and creativity that characterizes academe. Those parts of a University on which demands of professionalism and coordinated behaviour are placed, however, may be better fit for a centralised type of organisation. The fact that even Cambridge, an institution which embodies the classical University, has chosen to build central competences for innovation support, research contracts, corporate liaison, etc, sets an interesting precedence for competing institutions.

More than organising support for the third mission, the organisation of research and education may also have a great importance for the effectiveness of interactions with University stakeholders. During the project, we have come across many forms of research organisations designed for cooperative purposes. At KTH, the Competence Centres are prominent examples.

CASE STUDY XI

The Faxén Laboratory Competence Centre

"the strongest group in paper performing fundamental research in the world today" was how an international evaluation team described the Faxén Laboratory Competence Centre founded at KTH in 1994. The Centre, which researches the fluid dynamics of industrial processes, focuses on three research programmes – Electrochemical Processes, Materials Processing and Paper Technology – and currently works with 17 industry partners, a mixture of large, medium and small companies. It also has a significant partnership with Sweden's STFI research Institute; a public institute focused on the paper, pulp and packaging industries located close by on KTH's campus. Together these partners have been able to achieve massive advances in materials understanding *and* find applicability for these; the Centre's development of multi-layered paper techniques has been described as "the most significant innovation in paper forming technology in the last 20 years".

The Competence Centre model was developed by VINNOVA, the Swedish Agency for Innovation Systems, to encourage researchers to seek collaborations with industry. Industrial funders receive matching funding from VINNOVA and the host University (i.e. one third industry, one third government, one third University). This mechanism of engagement has proved very popular and KTH currently hosts 11 Competence Centres, Sweden as a whole has 28. The Centres see a critical part of their role as the production of PhD students and, as these people have been trained in a unique University/industry environment, they are in high demand after completing.

Funding – securing innovativeness and independence

A modern University will fund the majority of its research efforts from external sources, in competition with other universities. KTH attracts two thirds of its research funding from the new "grants economy" in Sweden. The bulk of resources for these grants still come from the public sector. External resources however tend to be tied to more applied than basic research, and more problem-driven than curiosity-driven projects; this has put new pressures on core funds for both education and research.

Benchmarking the level of such "core funds" in the seven compared European Universities, we find that KTH is less dependant on direct government sources than the Dutch or Swiss technical universities (which may be seen as another way of saying that these have stronger state support). The University of Surrey stands out as strongly independent – only one third of the total annual budget comes from direct government funding and research councils. Part of this freedom is explained by the right to charge tuition fees and the wealth that the University is able to create from its land and buildings assets with a book value of 1.2 billion SEK.

The bench learning experience illustrated that approaches to funding still differ between countries from the dominance of private money in parts of the US system to the dominance of free public funds, when compared to Sweden, in the Dutch system. All Universities attempt to find funding for innovative activities at the margin of their national systems. At Cambridge and in Zurich, ambitious campaigns to raise funds from private and corporate donors have been initiated during the last few years. Both these renowned Universities refer to increasing failure of government funding to allow satisfactory research and education quality. Slightly contradictory, both Universities also refer to a need to decrease dependence on government funding, allowing strategic investments. A large endowment, it is argued, would help create the necessary freedom and strategic ability that these old institutions need to maintain their success. A quick look at the balance sheets of these Universities reveals assets of enormous proportions. If these rich and successful Universities perceive a need to secure their funding, what does that say about the future competitiveness of KTH?[15]

[15] Cambridge University presents property assets of about 1,7 billion SEK. The University has a permanent endowment of 28 billion SEK, providing the University and its colleges with annual incomes on more than 1,2 billion SEK. ETH Zurich has buildings in Zurich and all over Switzerland, valued to 18 billion SEK. See Appendix X.

CASE STUDY XII

Introducing fundraising in Europe

Fund raising for universities on a serious scale is still a phenomena exclusively existing on a few successful American universities. ETHZ is one of few European universities that considers it possible to actually establish a significant foundation capital through endowments. In 2003, a foundation for this purpose was introduced. The stated strategic purpose is to increase non-governmental funding of the ETHZ. The *ETH Foundation* shall "support strategically important projects and the international competitive ability of the University". The strength of the Swiss economy and the importance of ETHZ to Switzerland are factors facilitating successful fund raising, and it can be noted that the national interest is stressed in the foundation's rhetoric. The vision that donors are asked to support is that of the Switzerland/Alpine space as the "Boston Area of Europe", of the Zurich area as a natural hub for this region, and of the ETH Zurich as a very important institution for this region. This perspective is also stated as "Switzerland/Europe needs at least one University rated among the world's best".

The organisation and philosophy driving the Foundation's work is similar to that of a start-up firm. Customers segments are identified, potential markets evaluated, vision and strategy clearly elaborated; in short the Foundation has an impressive business plan and a professional commitment to its challenging task.

The ETH Foundation has the operative goal of collecting 1 billion Swiss francs (6 billion SEK). In order to be successful, the foundation must introduce a Swiss version of the American fund raising culture, and create stronger ties to ETH Alumni. In this respect, the work of the ETH Foundation is of interest to national and international 'competitors', who live under similar circumstances. If some technical universities successfully introduce University funding, may not others be able to benefit from their example?

How can KTH address this theme?

Investments in Recruitment

One way in which discussions of centralised vs. decentralised management can be addressed is through a consideration of recruitment. If KTH recruits the right type of people, both academic and administrative, they will act together, and with ambition, for the future of the University. Staff recruitment is a core management issue in this context. With regard to research, no University can have a recruiting policy that will value anything but academic credentials. The project members noted how MIT emphasized that it does not recruit for industry experience among the teaching Faculty. Professor Malcolm Longair of Cambridge's prestigious Cavendish Laboratory spoke at length about the efforts made to find the right people at the right time in their career. The example of the Brain Mind Institute speaks the same language.

The work done by Professor Jan Anders Månsson in developing the innovation system of EPFL is an example of excellence in recruitment in management. Bringing him in as a Vice Rector for third mission work is a strategic recruitment indeed. The Swiss examples show that KTH can be more proactive in this regard. Recruiting younger Faculty with an international experience will also contribute to third mission awareness. There is a new generation of researchers who have been exposed to the grants economy of the modern "porous" universities and KTH should work hard to recruit these able people.

Recruitment again

The visits suggested to KTH Faculty that we have a new professional role in the University system. The profession demands research and education to provide legitimacy. Increasingly it also demands experience and training in both University and industry environments. Whilst KTH has stressed a need for third mission professionals above, if these people are only recruited at a central administration level, the Faculty may well assume that third mission is "taken care of". As argued previously, vital in enabling strategic industry relations at the Universities visited were dedicated teams of professionals in this area – *actively supported by experienced senior Faculty.* An answer to this is to encourage Professors to develop relationships with industry, and to develop KTH relationships with industry alumni and others that can be guest lecturers, and perhaps guest Professors. One strategy might be to review adjunct Professor rosters for each school, identify gaps and create strategies for filling them. Another solution might be to provide clear and sustained incentives for those Professors who want to work more closely with industry to do so.

What about a prize?

Other countries have found it useful to clearly mark out and reward, in honorary terms, those individuals who make an exceptional contribution to innovation and relationship development activities. KTH is keen for similar prizes to be developed in Sweden. Should KTH found its own prize for its own Faculty or should a relevant company or agency sponsor a nation-wide prize?

Producing a model of KTH's innovation system

VINNOVA's work has aided KTH in appreciating a need for it to address its own Innovation System. Again in Switzerland, in particular at EPFL Lausanne, the universities were able to produce clear overviews of their Innovation Systems that captured a vision and provided a mechanism for operation. Surrey University also seemed to have successfully grasped this nettle. There is work here for KTH to do. The Entrepreneurial Faculty Pro-

ject has set off many ideas; alongside developing these ideas, KTH must also work to ensure that they complement and reinforce each other – that they are part of a clearly understood and actively enabled Innovation System.

Conclusions, Actions and Recommendations

Innovation and collaboration efforts should not be "concluded". The research base of any University, and the environment in which it is situated, develop constantly. The structures, activities and people that link these, therefore, must also continue to evolve, always seeking to identify and deepen best practice.

Whilst respecting these dynamics, this project was undertaken with goals in mind and must put forward routes for progress. In outlining these routes it is useful to return to the start of the project and guidance provided by Burton Clark. Professor Clark identifies "5 Pillars of Transformation"; activities Universities that have become more entrepreneurial have undertaken. It is possible to describe what KTH has achieved towards each of these pillars through this project – and consider what further actions should be undertaken.

5 Pillars of Transformation	KTH's Progress	Next Actions
1. a strengthened steering core	• a core group has been activated supporting change • a need for a coordinated group for innovation and relationship development activities is recognised	• establish a permanent "EFP group" to coordinate different partners and undertake a strategic analysis of KTH's future actions - and build further support for change • ensure this group is structurally linked to KTH's steering core and the Faculty Board, providing management information on innovation and stakeholder relations for them • together with the Rector, consider redeveloping KTH's strategy document to include a clearer commitment to innovation and relationship development
2. an extended developmental periphery	• useful ideas have been identified e.g. Industry seminar series, valourisation funding • Schools are evolving innovation and relationship development strategies	• review and consult on current activities e.g. auditing stakeholder relations and levels of satisfaction • transfer success stories to other parts of the university • develop proposals for further engagement both at a central and School level • review the recruitment and retention of "third mission" staff

3. a diversified funding base	• significant questions are being asked	• audit KTH's current income streams considering their "quality" as well as quantity • asses whether philanthropy a specific channel that should be further investigated? • examine overhead issues and competitive pricing
4. a stimulated academic heartland	• created a realisation of the need for development in the academic heartland • discussions on developing academic quality and including innovation within this underway e.g. Quality Project	• develop a profile of KTH's research competences, using this to make better quality managerial decisions • proposals for career development e.g. new criteria for recruitment and promotion that encourage innovation activities, require further exploration • review KTH's staff Handbook considering how innovation activities can be better expressed within it • develop an internal communication strategy for innovation and relationship development activities
5. an entrepreneurial culture	• KTH knows this is what it has to get right	• again, reconsider KTH's key strategy documents and strengthen their commitment to innovation • support the founding of a prize for Faculty shown to • work actively with student groups to support their activities • review the teaching style at KTH; does promote innovation and engagement as well as academic success?

Early Results: positive activities already underway

As a result of being championed by the Faculty Board, this project has clearly stimulated KTH's academic heartland, in so doing establishing a community of support for further innovation and collaboration activities. Through introducing KTH to different activities, the project has suggested further initiatives to extend KTH's periphery. Indeed, a key result of this project is the wealth of ideas highlighted in this text that KTH is now aware of and able to explore developing further. The independence of action that a diversified funding base provides has also become highly apparent to the University.

KTH has made use of its learning already through a series of actions:

- Driven by the insight that any ambition towards increasing the strength and efficiency of links to the private sector must be based on academic values and harmonize with University culture (see Chapter 2), KTH has initiated *a review of ethical principles* to guide efforts in the borderland outside the two core academic activities of teaching and curiosity driven research.

- In connection to this, the Faculty board intends to review regulations and practises for academic promotions, developing new career paths for Faculty with interests and abilities to work in interfaces between academy and its stakeholders. In the spirit that an entrepreneurial culture is created and strengthened through constant manifestations (see Chapter 2), KTH is also increasing its efforts in the area of open seminars and other forums where topical issues may be aired and debated.

- Studying the issue of cooperation with industry, the project has found indications that most of the compared Universities are able to offer "cheaper" forms of cooperation, which may increase their ability to establish relations to this important group of potential stakeholders (see Chapter 3). KTH has therefore decided to *review the way overhead costs are distributed and charged in research contracts*.

- KTH, together with VINNOVA, will also host a series of strategy seminars with partners from industry and other stakeholders to debate and identify best practice in University interactions.

- Natural intersection between academe and it's stakeholders through physical co-location (see Chapter 3) is one of the basic ideas behind the establishment of KTH's ICT-campus in Kista. The heavy concentration of public research institutes at the main KTH Campus, and the incubator facilities there, are similar examples. Wishing to continue building environments that allow for spontaneous meetings between people and ideas, KTH is developing plans to enable an industry presence at its "sub-campus" in the Albanova area. This environment, where two Universities (KTH and Stockholm University) have joined forces to allow new meetings between the sciences of physics, bio-technology and astronomy, was not planned for industry originally. Further development that engages industry may strengthen this already successful experiment.

- In the execution of the Entrepreneurial Faculty Project, KTH's Faculty been impressed by the active participation by student representatives. There is now consensus around a vision that students, Faculty and University management shall work side by side (see Chapter 2) to deepen the project. KTH has decided, for example, to map currently running student initiatives in "third mission" areas.

- A number of project-related initiatives are being driven from one of KTH's ten newly founded Schools. To encourage increased efforts in commissioned education, plans are being made for the introduction of a new subsidiary to the KTH Holding Company, which is to support and organize the activities in the Schools in this area. The establishment of a student council at the School of Architecture and structural planning, which was inspired by student related activities at MIT (see Chapter 2), is a further example of project outcomes. An open seminar, presenting this School to potential industry partners has also been introduced (see Chapter 6).

- Together with regional partners, KTH is also discussing how the *regional role of the University* could be assessed and better understood. A feasibility study has already been launched. Both these measures aim at providing a stronger basis for improved quality processes at KTH. Results from these initiatives may also prove important for communication and branding (see Chapter 6) as the University is able to clearly articulate strengths and international positions.

- Last but not least, the Faculty Board has found the process of learning through organized studies in comparison to and together with national and international partners very rewarding, and intends to increase efforts and competences in the areas of surveillance and internal awareness of activities. An *internal review of the academic competitiveness of the University*, discipline for discipline, is being planned. Guided by experts in the field, KTH hopes to develop its own competences to allow continuous monitoring and comparisons to other Universities.

Further actions such as the roll out of valorisation funding for research projects with high commercial potential and an industry-university R&D seminar series are also being developed.

KTH – developing the strengths of an Entrepreneurial University

Although it is encouraging to note the multitude of paths leading forward, concern has been raised that enthusiasm might lead to fragmentation. KTH and its funding partners have invested in innovation initiatives for many years now. Whilst pleased with results, in the future even greater impact can be achieved through the better coordination of activities. The Faculty Board, in a similar vein, has requested that *unified* and actionable strategy for innovation and collaboration activities be written. There is a clear need for coordination, as well as enthusiasm.

Burton Clark (1998) makes this point:

″University transformation, for the most part, is not accidental or incidental. It does not happen because several innovative programs are established here and there within a university… It does not happen because a solitary entrepreneur captures power and runs everything top-down…

Rather, transformation occurs when a number of individuals come together over and number of years to change, by means of organized initiative, how the institution is structured and orientated. Collective entrepreneurial action is at the heart of the transformation phenomenon".

KTH needs to establish a forum to strengthen and support the collective entrepreneurial action this project has stimulated.

Secondly, many of the ideas put forward e.g. reviewing recruitment strategies, identifying sources of philanthropic funding, reviewing KTH's strategy documents, require further development and will have impact over the longer term. It is relatively simple to identify projects for action in the short term; KTH needs also to establish a programme, indeed a proper strategy, for evolution that recognises both long term and short terms goals and works to identify the synergies between these.

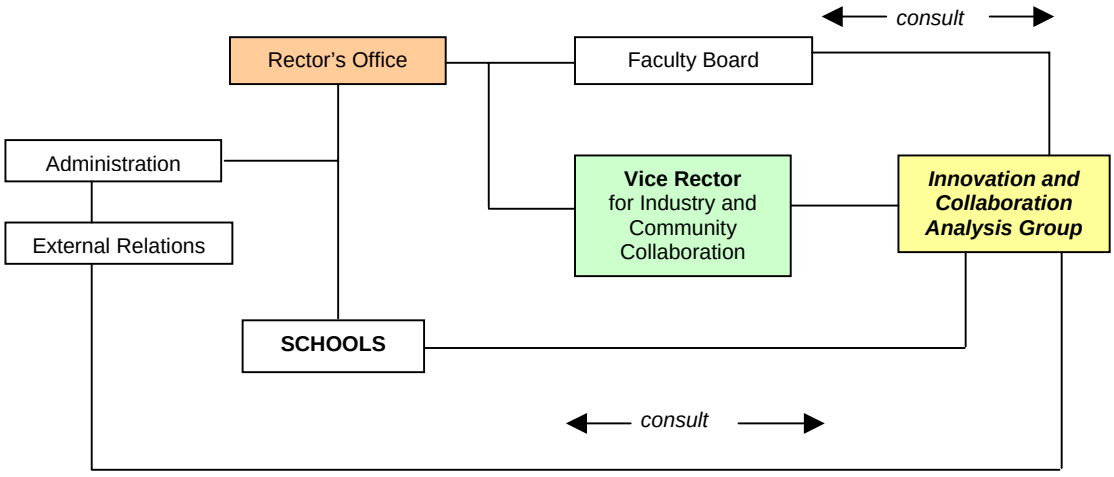
Whatever form this strategic programme takes, it is apparent that a single body should be identified to guide its formulation and ensure its implementation – even if this body is not responsible for executing actions. To date the Faculty Board has owned the project; should, *and can*, it continue to do so?

A forum for Collective Entrepreneurial Action

The Faculty Board provides a vital link to KTH's academic heartland meaning that proposals put forward have support on campus. Innovation, however, is not strictly the business of this Board and, significantly, it has few resources to deal with it. KTH has recently appointed a new Vice Rector for Industry and Community Cooperation. Should responsibility for developing a unified strategy be given to him? Again, the issue of lack of dedicated resources and capacity for planning will be raised, as Vice Rector posts come with scant budget.

Also, in taking away direct responsibility from the Faculty Board there may be a danger that plans will be developed without full academic input and will only effect "third mission" parts of the University. Considerations concerning centralised capabilities, as raised in the introduction to this report, also need to be taken in to account.

It is obvious that a *funded* and *strategic* resource of some sort needs to be established to support the University. It will be suggested here that the incoming Vice Rector for Industry and Community Cooperation be identified as the Chair of any such strategic analysis group and that his office be funded to develop ideas put forward in this document appropriately. The goal of this group should be stimulating and supporting *collective entrepreneurial action* across KTH.



A model for the coordination of an innovation and collaboration group

Ensuring a collaborative approach internally too

The Vice Rector will undoubtedly want to continue to receive the high levels of academic input this project has so far achieved and, therefore, at least one Faculty Board representative should play an active role in the functioning of this group, as should a student representative from the Faculty Board. The Faculty Board may want to take specific responsibilities for running some projects, especially those concerned with university culture, teaching and staff development.

A role for the Schools must also be clearly identified in the group as these new organisations will be critical in implementation – and, of course, are key sources of intelligence in planning. It must also collaborate with already existing activities run through KTH External Relations and, indeed, may want to second staff from this office. Through his office, the Vice Rector has natural links with KTH's management meaning plans will also receive central input and the group will be able to act as a management resource.

Towards the future

Innovation and collaboration, as noted above, are dynamic. KTH's traditional University structures are already heavily committed to important areas of governance. As KTH recognises the significance of activities in this field, it is recommended that a new, dedicated group, under the championship of the Vice Rector, is established with a mission to deliver value for the Faculty and society through developing a unified KTH strategy for innovation and collaboration.

So, this project has necessarily identified many points of action. Rather than focusing only on "third mission" issues, it has quite rightly looked at the functioning and culture of KTH as a whole. KTH recognise that to succeed in innovation and collaboration it must weave the "third mission" into the very fabric of the university, allowing it to inform and develop approaches to education, research and management. The Entrepreneurial University must be willing to undertake purposeful change, and KTH has reached this point. There is much from KTH's proud history that it can - and should - take with it, using this intelligence to guide new choices that will ensure an exciting future for KTH, and the communities it serves.

Appendix I: People in the Project

Swedish project participants

	UK	NL	US	CH	
KTH Participants					
Professors					
Folke Snickars	X	X	X	X	Faculty Dean, Project Leader
Björn Hårsman	X	X	X	X	Dean, School for Architecture and Structural Planning
Bengt Lindberg	X	X	X	X	Dean, School for Industrial Engineering and Management
Mats Hansson			X	X	Vice Rector for Education
Lars Holst	X		X		Vice Faculty Dean
Bastiaan Kleijn	X	X			School of Electrical Engineering
Gunnar Landgren		X	X		Vice Rector for Research – director of the IT-University
Jan Grandell		X			Member of the Faculty Board
Margareta Norell			X		Pro Rector for Recruitment
Håkan Snellman	X				School of Engineering Sciences
Tuula Teeri				X	Vice Dean, School of Biotechnoogy
John Ågren	X				Member of the Faculty Board
Faculty Board					
Anders Lundgren	X	X		X	External delegate – Scania
Camilla Modeer			X	X	External delegate – IVA m m
"Third mission" functions					
Kenneth Billquist	X		X		KTH Innovation
Lisa Ericsson	X		X		KTH Innovation / KTH Holding
Peter Holmstedt	X			X	Director of KTH Holding, Vice Rector for the Third Mission
Emma Källblad	X		X		External Relations – Entrepreneurial Faculty Project Group
Gunnar Ivmark		X	X		Director, Central Administration
Bengt Finnström				X	Director, External Relations
Anders Hugnell	X				Engineering Institute
Douglas Reincke	X				KTH Lawyer
Student representatives					
Mattias Edling		X			Member of the Faculty Board
Per Haraldsson	X				Member of the Faculty Board
Dag Lindbo			X		Member of the Faculty Board
Staffan Lundström			X		Chairman, student entrepreneurship club "Excitera"
Odd Runevall				X	Chairman of the Student Union
Faculty Administration					
Åsa Gustafsson				X	Rector's Planning Unit
Ulla Malm				X	Secretary to the Faculty Board

	UK	NL	US	CH	
Other Project Support					
Anders Broström	X	X		X	SISTER / Entrepreneurial Faculty Project Group
Clas Wahlbin		X	X		Mentor of the Entrepreneurial Faculty Project
Amy Rader Olsson			X		Entrepreneurial Faculty Project Group
VINNOVA					
Sven Gunnar Edlund	X	X	X	X	Director, Innovation Actors Division
Susanne Andersson		X		X	Innovation Actors Division
Lars Olsson	X	X	X		Innovation Actors Division
Ylva Sjönell			X	X	Chief Information Officer
Innovationsbron					
Göran Reitberger	X		X		Programme Director – University-industry cooperation
Tor Kihlberg				X	Programme Director – Seed Financing
Tomas Lundin	X				
Björn Varnestig				X	Director
Other organisations					
Barbro Berg	X				Stockholm City
Enrico Deiaco		X			SISTER
Peter Johansson			X		Confederation of Swedish Enterprise
Tomas Malmer				X	Royal academy of Engineering Sciences
Jörgen Sjöberg		X			Chalmers University of Technology

Principal contributors from visited Universities

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Professor Ken Taylor, special advisor to the Vice Chancellor

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Helen Atkins, Research Services Division

Gauri Bhalla, Head of Business Development, Corporate Liaison Office

Professor Michael Kelley, Director of Cambridge MIT Institute (CMI)

Professor Michael Longair, Head of the Cavendish Laboratory

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Moana Pledger, Head of regional university-industry network i10

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Sjoerd van Tongeren, deputy director Holding Technopolis Twente

Dr Patrick Strating, Telematica Instituut

Eric Jan de Widt, Director, Holding Technolpolis Twente

Professor Henk Zijm, incoming Vice-chancellor

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Meine Oosten, Business Manager, Faculty of Aerospace Engineering

Professor Hans Van Luijk, President

Mariëtta Spiekerman, Senior Policy Advisor on Internationalisation

Olaf Stroosma, SIMONA Research Simulator

Professor Marco Waas, Dean of the Faculty of Mechanical Engineering

At Massachusetts Institute of Technology

Professor Ed Crawley, Head, CMI

Dr Anthony St George, Associate Dean, Alumni and Communications

Sherwin Greenblatt, Director, MIT Venture Mentoring Service

Dr Eli Guy, Vice President of Engineering, Draper Laboratory

Joe Hadzima, Board Member and Managing Director, Main Street Partners, LLC

Krisztina Holly, Director, Deshpande Centre for Technological Innovation

Dr Alison Hynd, IDEAS competition

Dr Josh Jacobs, Manager for Education, CMI

Professor William Litant, CDIO

Professor Bill Lucas, Deputy Director and Head of Assessments

Dr Lita Nelson, Office of Technology Licensing

Jose Pacheco, Centre for Entrepreneurship

Johan Pontin, Boston Head of POD Holding

Professor Mitchel Resnick, MIT Media Lab

Marie-Teresa Vander Sande, Office of Corporate Relations

Professor Jim Utterback

Professor Dick Yue, Associate Dean, School of Engineering

At Tufts University[16]

Professor Sergio Fantini, Associate Dean, School of Engineering

Pamela Goldberg, Director, the Entrepreneurial Leadership Program

Professor Chris Rogers, Director, Center for Engineering Education Outreach

Professor Chris Swan, Department Chair

Dr Arthur Winston, Director, the Gordon Institute

[16] A visit to Tufts University in Boston was included in the project. We have, however, chosen not to include findings from this visit, or a description of the institution in the report or in the appendices.

At EPF Lausanne

Dr Gabriel Clerc, Director Industrial relations office (SRI)

Dr Stéphane Decoutère, personal advisor to the director of the Swiss Federal Office for Professional Education and Technology

Dr Benoît Dubuis, Office of the Vice-President for Knowledge Valorization

Professor Daniel Favrat, Director of Institut des sciences de l'énergie

Professor Dominique Foray, Dean, College of Technology Management

Dr Jacques Laurent, Director, EPFL Science Park

Dr Hervé Lebret, Licensing Officer

Dr Roland Luthier, Head of Corporate Liaison unit CAST

Professor Henry Markham, Director, Brain and Mind institute

Professor Jan-Anders Månson, Vice President for Knowledge Valorization

Professor Jean-Jacques Paltenghi, President, EPFL Science Park

Professor Martin Vetterli, Vice President for International relations

At ETH Zürich

Professor Göran Andersson, Director, Power Systems Laboratory

Professor David Basin, Director, Zurich Information Security Center

Dr Roger Baud, Alliance for Global Sustainability

Dr Silvio Bonnaccio, Director, ETH Transfer

Dr Wilfried Elspass, Center for Product Design

Professor Gaston Gonnet, department of Computer Scicene

Professor Olaf Kübler, President

Maya Lalive d'Epinay, Director, ETH Foundation

Rolf Probala, Director of Corporate Communications department

Lesley Spiegel, Director, Zürich Technopark

Professor Hans Thierstein, Prorector for International relations

Special visit to the ETH board

Dr Kurt Baltensperger

Dr Sebastian Brändli, general secretary

Professor Ernst Buschor, vice-president

Dr Christoph Grolimund

Appendix II: KTH

Background and description

KTH, the Swedish abbreviation for the Royal Institute of Technology, won its name in 1877, as the institution, previously named Technological Institute of Stockholm, entered a phase of enhanced academic ambitions. In its fifty years of existence, the institute had struggled with the balance between industrial and academic demands, as manifested in its still prevalent motto "Science and Art".

The University has a large campus area situated in the north of central Stockholm, where seven of the nine KTH Schools have their main activities. A School for ICT is based in the telecom intensive suburb Kista and bachelor-level education is based on three campuses in southern Stockholm suburbs Haninge, Södertelge and Flemingsberg.

Increasing competition

As Sweden's oldest and largest University of technology, KTH has a natural leading place. But even if KTH celebrates many excellent research achievements and dominates the national scene for technical education (a third of Swedish engineering education is placed at KTH), the University has for at least two decades faced increased national competition. As a result of a long period of expansion in higher education, motivated by ambitions of widening participation and regional development, Sweden now has a higher number of higher education institutions offering technical education than any comparable country. Resources for engineering research are also widely distributed.

KTH, more so than any other Swedish institute of technology, sees itself has having a national as well as a regional role to play. But in light of relatively recent developments, the University has to work out how it can develop into the national powerhouse of engineering it wants to be, with ever more strained resources. Sceptics ask whether there really is room for an excellent institution in a small country where nine Universities and University colleges compete over national research funding.

Towards a more stream-lined organisation

The KTH organisation has transformed slowly over the last fifteen, going from a very decentralized University with a large number of small institutions towards larger organizational units. Under its current Rector, Professor Anders Flodström, the transformation has continued and today KTH is

organised in nine large Schools. Many argue that the larger organizational bodies the School system provides have enabled stronger research and produced synergies for research in particular as each School Dean is responsible for producing a strategy for his or her School. It is still too early to evaluate the effect of this last reorganization but the ambition is that the Schools will constitute stronger collaboration partners, leading to improved abilities for dynamic out-reach.

Third mission approaches

Industry relations

Similar to other well-established technical Universities, KTH researchers traditionally have strong connections to industry. Through the *External Relations* office, KTH offers assistance in connecting industrial partners to researchers, either for short consultation or more ambitious relationships. The office does not currently work with active development of industry relations. A more active approach is used by the *Engineering Institute*, situated in the school of Industrial Engineering. The Institute, which specialises in contract research, presents itself as a gateway to KTH expertise for industrial partners. The *KTH Executive School* also upholds important contacts to industry, offering courses.

Connections to independent research industries

With their competences in application-oriented research, the large number of research institutes situated at KTH campuses constitute intermediaries between the University and industry and, for researchers, intermediaries between academic and commercial careers. KTH is continuously discussing how cooperation between the institutes and the University can be strengthened, and a joint analysis has identified a number of ”strategic innovation milieus” where the potentials for productive cooperation are high.[17]

Innovation support – the new agenda

Increased commercialisation of University research has long been on the Swedish policy agenda. Universities have been called upon to form holding companies, engage in incubators and science parks and offer advice and support to Faculty and students with an interest in high-tech entrepreneurship.

[17] Eriksson, K., Ericsson, L. (2005), *Samarbete mellan KTH och kringliggande industriforskningsinstitut –*
nuläge och utvecklingsmöjligheter, Vinnova Rapport VR 2005:10.

The small *KTH Innovation* unit offers advice and guidance for Faculty. The unit also promotes entrepreneurship through workshops, seminaries, competitions and regular courses. The *Stockholm School of Entrepreneurship*, a joint initiative by four Stockholm universities, offers courses on different aspects of commercialisation of technology and starting up a business.

KTH recently announced its intention to support the formation of *STING*, Stockholm Innovation and Growth in cooperation with the city council, the Innovation bridge foundation and other partners. STING Business Lab and Business Accelerator programmes will help fledging companies roll out their plans, with mentor and other support. In return STING will take special share options that, should the company become profitable, will give it a cash reward. STING has recently announced the foundation of an associated 22MSEK Venture Capital company.

For companies in more mature phases, KTH also cooperates with two tech parks, none of them, however, directly controlled by or owned by the University.[18]

New Vice Rector appointed

A sign of the increasing importance assigned to activities around the "cooperation mission" of universities is the appointment of KTH's first Vice Rector for cooperation in 2003. At the time of writing, a new Vice Rector is on the way in. It remains to be seen how the organisation of will develop and which missions it will be giving priority to under new leadership.

Lessons from KTH

The adopting organisation

Most of the schemes in which KTH takes pride are created and based in departments or centres. However, as KTH increases its ambitions in the "third mission" area, the University is learning to benefit from successful schemes and internal practises by expanding them to the wider University level. In this manner, KTH has initiated an expansion of the successful KIG support scheme for high-tech ventures from suburban Kista to Stockholm. In a similar fashion, successful department centres with important functions have been, or are in the process of becoming, recognized as important for the entire organisation as thus reorganized to sit with central functions. Such is the case with *KTH International* and the *Engineering Institute*. Through

[18] KTH is one of ten owners of the foundation Science city, which owns the tech park facility *Teknikhöjden*. The tech park facilities in Kista are part of the STING-scheme, in which KTH is an important partner.

this technique, the University seems to be able to build strong functions without creating the unnecessary rigour of a centrally planned and centrally run system.

Centres – where science meets business

At KTH, research centres with industry participation play an important part for the University's knowledge valorization efforts. Centres are typically focused around areas of application, and thus inter-disciplinary in scope. This set-up makes it natural for industry to participate and/or sponsor research, and centres normally have boards with strong industry presence.

A particular group of centres are the *Competence Centres* founded as a result of an initiative by the Swedish Agency for Innovation Systems (VINNOVA) and its precedents. Hosting a third of the 28 competence centres established in 1995, KTH has been a main benefactor from the programme. The Competence Centres are characterized by strong industry involvement, clear IPR rules and a research agenda shaped by industry needs.

In centre- and institute organizational forms, KTH has found important tools for building the bridges between technical science and industrial technology that are necessary both for breathing life into research agendas and for encouraging industry funding of universities.

Appendix III: The Massachusetts Institute of Technology

Background and description

MIT, one of the world's foremost technology research institutions, is located near Boston on America's east coast. Founded only in 1862, MIT has sought and won a worldwide reputation for excellence. In so doing it has challenged conceived ideas about what a University should be, indeed the nature of research and purpose of academe. MIT, perhaps more than any other University, is proud to champion "use-inspired basic research". Whilst always pushing the frontiers of knowledge, many MIT researchers also seek applications for their ideas or take inspiration for deep science from problems in the world. Today, MIT leads many University ranking tables with its researchers being some of the most productive and highly cited found.

The University actively communicates its successes and the MIT brand has become synonymous with innovation. It has fostered both local and global links and is surrounded by a healthy R&D cluster that brings together spin-offs with international conglomerates.

MIT presents a significant challenge to European universities. Often inspired by the impact the University has had on the US's economy, many universities visit its campus seeking inspiration, Cambridge University's alliance with MIT being a clear example of this. On returning to Europe, enthusiasm for the MIT model seems to wane with few universities having the resources, or possibly need, to carry through programmes with the ambition MIT does. Many argue the MIT model does not "fit" Europe or European Universities; whilst this many well be the case, Europe has yet to clearly identify another model that delivers the scientific and economic impact of MIT.

Engaging with Society

The mission of MIT is to "advance knowledge and educate students in science, technology, and other areas of scholarship that will best serve the nation and world". It has as its motto "Hand and Mind", a statement that clearly links research to application in the world. Supported by this mission and motto, MIT researchers and students see it as natural, indeed almost noble, to carry their research through into society.

The University's culture provides strong support for innovation and spin-off activity. Perhaps more significantly, the ambition of Faculty to continually undertake bigger and better science makes many of them "funding entrepreneurs" who continually seek to muster resources from multiple partners to drive forward their work. Through seeking commercial funds to top up government grants, MIT researchers have learnt how to develop their ideas in a manner attractive to industry. Whilst a clear majority of MIT's research funding still comes from government agencies, the 11% that comes from industry seems to have a disproportional impact, perhaps because this funding reinforces MIT's extrovert culture, as well as supplying further funding?

MIT has been both intelligent and strategic in publicising the impact its engagements with society have had on the economy. Mostly notably in the early 1990s MIT collaborated with Bank of Boston on a report that clearly demonstrated its impact on the US economy. The report found that MIT graduates were responsible for having founded 4,000 firms, which, in 1994 alone, employed at least 1.1 million people and generated $232 billion of world sales. More recently the 8 universities in the Greater Boston region published a report that showed that:

- In 2000 (the last year for which figures are available), the collective revenues of these universities totaled more than $5.8 billion; the Universities spent $1.5 billion on research.
- They employ 50,750 people directly and the universities' spending on payroll and purchases supports a further 37,000 full-time equivalent jobs in industries through out the region.
- Enrollment at the eight universities totaled more than 118,000 undergraduate, graduate and professional students in 2000 and 32,000 degrees are granted per year.
- In 2000 the universities were granted 264 patents, signed 250 commercial licensing agreements and helped form 41 start-up companies.
- **In total, the eight Universities provide a $7 billion annual boost to the region's economy.**

This type of information has been most useful to MIT in raising its profile and making a case for continued support form local and national governments.

Organisation

MIT is organised as five schools and one college with a total of 900 faculty and ten thousand undergraduate and graduate students. The Schools are:

- Architecture and Planning
- Engineering
- Humanities, Arts and Social Sciences
- Management
- Science
- Whitaker College of Health Sciences

There are also several centres, programs and laboratories for multidisciplinary research as well as within each school, the MIT Media Lab, within the School of Architecture, being one of the most well known. The Lincoln Laboratory, a federally funded research institute focusing on defence and communications, is considered as part of MIT. Several independent research institutes e.g. the Broad Institute (Biomedical), the Draper Laboratory (Electronics and Defence) and Whitehead Institute (Biomedical) can also be found surrounding the campus.

Whilst MIT has a highly decentralised and "emergent" culture, the above diagram illustrates it also has a focused and well-resourced management. The Deans of Schools and the University Executive, most notably the President, play an active role in developing strategic initiatives, supporting key relationship and guiding *some* activities. MIT has no "Strategic Plan" but it is clear that its Faculty have strategic objectives e.g. a Brain and Cognitive Sciences Department has recently been launched, and that a professional University administration works closely with Faculty to coordinate and support these.

Each School also has considerable managerial support with the Dean of the School of Engineering, for example, having a professional staff to manage the School's strategy and relationships, in particular with alumni. Work with alumni and corporations have given the School of Engineering independent wealth, which the Dean sometimes refers to as his "war chest" and uses to invest in initiatives. A powerful and well-resourced centre and powerful and well-resourced Schools undoubtedly leads to duplication and occasional conflict. Competition and cooperation between the different support systems seems to create an innovative and productive culture in management, mirroring and supporting the academic atmosphere on campus.

Third mission approaches

MIT seems to have innumerable projects designed to better links between industry and the faculty; mostly geared towards improving knowledge transfer from the University outwards and increasing the wealth of the MIT Corporation, but also inviting industry representatives to help teach business and entrepreneurial skills to MIT students and faculty. Indeed, it has such a web of entrepreneurship and innovation programs throughout the organisation that it is somewhat unclear if or how these many centres/programs/initiatives etc. relate to each other. As noted above with regard to University management, there is healthy competition between initiatives, possibly ensuring that only the best ideas survive.

The *Technology Licensing Office*, which oversees patenting and licensing issues, is within the office of the Vice President for Research and Associate Provost (also director of Whitaker College). This organisation also runs the Technology and Development Program which describes its goal as developing partnerships among industry, government and academia to help developing countries. MIT has well developed mechanisms for creating wealth for the University through exploitation of intellectual property. Its annual income from licenses is about 73 million dollars, the second highest in the US (Source: Högskoleverket).

This operation is functionally separated from the Office of Corporate Relations (OCR) and the Industrial Liaison Program, (ILP) which are organised under the Executive Vice President's office, Vice President for Resource Development in association with the Alumni Association. The Industrial Liaison Program has existed since 1948 and employs Industrial Liaison Officers with responsibility for providing personal, individual assistance to companies seeking a closer relationship with MIT. Participating companies become members of the Industrial Relations Program that allow them access to members-only services such as Faculty visits to the member company, private workshops, special publications, conferences, and events.

MIT also has a Government and Community Relations office, but this is organised directly under the office of the President of the MIT Corporation. Relations to the US federal government are handled through a Washington DC office reporting to the Vice President for Federal Relations.

Other activities, particularly those related to spinning off research, are organised on a School level. Within the School of Engineering for example, the Deshpande Center for Technological Innovation funds innovation research, funds proof-of-concept testing with "ignition grants," showcases MIT technologies and links entrepreneurs within MIT with business partners. The Deshpande Center was created with a twenty million dollar private grant. The Center also produces events for local entrepreneurs, investors and faculty through so-called Ignition Forums and works together with the MIT Licensing Office (MIT central administration) and the MIT Entrepreneurship Center (within the Sloan School of Management) to help bring its funded projects to market.

The *Entrepreneurship Center* is within the MIT Sloan School of Management and focuses on training for students, faculty and professionals. The Center offers both educational programs and also networking opportunities, technologies and resources. It acts as a clearinghouse for information about a variety of MIT programs and affiliated/external networks such as the Engineering School's *Center for Innovation and Product Development*, the *MIT Entrepreneurs Club*, the *Technology Capital Network* and the MIT *Center for E-business*.

In short, MIT seems to have an expansive and active culture fostering partnerships with businesses and offers a variety of resources to improve them.

Lessons from MIT

Rigorously pursuing academic excellence to ensure excellence in innovation

When visiting MIT a guest would like to hear that they've recruited a different type of Professor, one skilled in technology exploitation, perhaps at the expense of academic excellence. This is most definitely not the case. It was pointed out on several occasions that Faculty and students are only appointed on academic merit. The argument followed that the skills that made you an excellent academic – a constantly questioning mind, an ability to set and reach clear goals, good communication skills, and great fundraising skills – were those that would help you to excel in business.

Academic excellence is taken very seriously at MIT. Even once tenured, MIT's researchers are continuously assessed. Each Department has a visiting board that reviews research and teaching on an annual basis. Whilst this is an internal process, rather than the government run "RAE" assessment as seen in the UK, it seems remarkably thorough and robust with hard criticisms being given. It is the goal of each MIT department, quite simply, to be the best in the world so feedback from external advisors is taken most seriously.

Perhaps even tougher is the continual assessment of Faculty by students. Students are free to move between courses in different departments, provided they eventually build up sufficient points to major in a field. Students, therefore, have an option to vote for good Faculty with their feet. Courses that are not well taught or thought relevant simply do no recruit and are therefore not funded. Dick Yue, Vice Dean of the School of Engineering noted that MIT does not expand to meet new needs; rather it reallocates resources, closing unproductive labs or unpopular courses.

This "harsh" academic environment is seen as vital for academic success – and also critical in sustaining an innovative environment. MIT Faculty are constantly expected to innovate, improve and maintain relevance, in so doing they come up with new approaches and, therefore, new transferable knowledge. The wider society around MIT has clearly benefited from this pursuit of academic rigour.

Learning from the Students

MIT Faculty are highly self-assured and confident of the value they provide. Amongst such efficacy it is interesting to find true humility about the "privilege" it is to teach. Students are seen as intellectual contributors to the University from the moment they arrive, rather than children to be educated. They are given a high level of respect and privilege, which can be evidenced

in small but meaningful actions such as the right for any student room booking to override other bookings.

Students, as noted above, select their own courses giving them a high degree of self-determination and freedom to develop their own, as opposed to the Faculty's, interests. They also have an Independent Activities Period (IAP) each January during which they may pursue their educational interest. Many students use this time (and the summers) to work in research labs meaning they graduate with a "hands on" appreciation of what it is to be a researcher and the most recent research findings. This period is also used by many students to develop their entrepreneurial skills; the Deshpande, for example, runs a programme that encourages students to get involved in exploring the commercial potential of research ideas.

Students are of course expected to actively contribute to lectures and question the knowledge of their Professors. They are also taught that knowledge is to be applied through programmes such as CDIO in Engineering that actively promotes the transfer of theory into innovations.

This respect seems to be paid back with the students making remarkable contributions to campus life and culture – this is especially true in the innovation field where the students run a 50K Business Plan competition and other initiatives such as the IDEAS Competition that promotes and rewards social entrepreneurship.

Actively seeking innovations and relations on behalf of Faculty

It should be noted that, whilst MIT encourages PhD students and graduates to start companies when they finish their educations, it does not encourage Faculty to leave the University, as they are too valuable a resource. Instead, it seems that MIT puts considerable effort into supporting its researchers to spin-off ideas and develop their knowledge partnerships without leaving the University. This support infrastructure is sometimes referred to as the "MIT Ecosystem".

As noted above MIT, has a highly efficient Office of Technology Transfer that assists researchers patent and market licenses. This professional support function allows the Faculty to concentrate on their core responsibilities of teaching and research. In a similar vein, the University also has an Office of Corporate Relations. This office seeks out relevant industrial partners on behalf of MIT's Faculty and actively manages the multiple dimensions of a company's relations with the University, again allowing Faculty to concentrate on producing great science.

More recently the *Deshpande Center* was launched at MIT's School of Engineering (see above). This Center supports academics in identifying and valorising the commercial potential of their research. It also connects them with MIT's extensive innovation support networks that might help them, for example, identify a manager for a spin-off.

Whilst Faculty can of course choose to leave the University to pursue business interests, through the active provision of professional support it seems that few see a need to leave. The MIT ecosystem supports researchers, perhaps a little like an ant colony supports its queen, ensuring that new resources are made available and outputs are developed appropriately.

Appendix IV: Universiteit Twente

Background and description

Presenting itself as "an entrepreneurial research University", the University of Twente (UT) represents a new kind of young European research and education institutions. Since its' founding in 1961, UT has put scientific focus on interconnectedness between technical and social sciences, with exceptionally strong emphasis on innovation activities. Presenting its research agenda, the University states that "it is impossible to imagine research at the UT without […] focus on practical usage". The University performs internationally prominent research in areas such as telematics (combination of telecommunication and information technology), biomedicine, chemistry, microsystems, and laser technology.

Crisis and turnaround of Twente region

The strong UT-management focus on fostering of entrepreneurship and knowledge valorisation has its' roots in the special context of the University and its' regional role. The University is situated in a, by Dutch conditions, relatively remote region on the German border. For many years the steel and textile industries provided the economic backbone of the Twente region. The rapid decline of these industries in the 60s and 70s lead to 25 % unemployment in the region. From the 80s and onwards, regional efforts have focused on fostering and attracting high technology businesses. From its' very start, expectations on the University to develop into a hub for technology and growing businesses has been strong.

The regional profile also shapes the knowledge valorization activities and cooperation patterns of the University. As opposed to the technical universities in Delft and Eindhoven, there simply is no larger firms or strong industry clusters present in the region around University of Twente. To build strong industry-University relations, the University is forced to actively work with and if possible strengthen regional companies with growth potential and to encourage start-up activities among students and faculty.

Beside the University, the region hosts a second strong research organisation: the *Telematica Institute*. One of four Dutch Leading Technology Institutes, the independent institute is based nearby the University Twente campus, enabling research cooperation and staff-sharing with the University.[19]

[19] In 1997, four research institutes were created to support and perform research in four areas identified as critical to future competiveness of Dutch industry. They all have significant inputs and participation from universities and industry partners.

Slow growth curve projected

With the smallest student counts of the three technical universities[20], the UT is something of a "little brother" in relation to Delft and Eindhoven. The University management has no conceptions about radical changes in this relation. The official goal is to expand research activities slowly through increased external financing beyond 50 % (46 % today). The road towards that goal goes through powerful concentration of research activities. Vice-rector Willem te Beest anticipates a development where the University narrows it's disciplinary span "down to three disciplines". Only through dedicated specialization, so mr te Beest, can a small University remain successful in an increasingly competitive world.

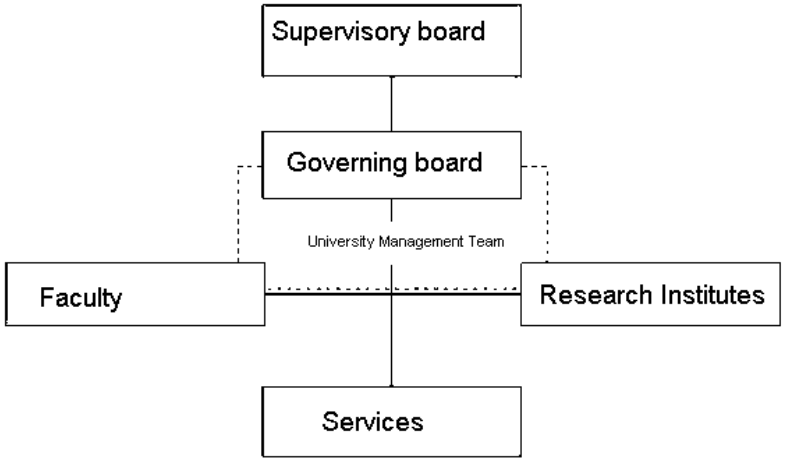
The University calculates for a slow growth on the educational side too, student numbers are to increase by five percent per year. This expansion is in part aimed at attracting non-EU-students. As part of this strategy, UT is moving towards a segmentation of tuition fees in the academic year 2005-2006 – when a radical increase of fees for non-EU students is planned: from € 1476 to at least € 8100 a year.

Organisation of research and education

Just as the other two technical universities, UT is organised in faculties and research institutes. Currently, UT has five faculties, where all academic staff are officially employed and where responsibility for teaching is laid. Research is organised in institute form. UT has six such institutes which are assessed as strong and broad, and therefore labelled "spearhead institutes". There are also ten smaller institutes/centres.

The University Management Team (UMT) consists of representatives from the governing board, the deans of the faculties and the scientific directors of the research institutes. In the UMT consultation takes place concerning all subjects of strategic importance.

[20] The UT has a steady "market share" of about a fifth of the students in higher technical education..



National and international cooperation with universities

The three Dutch technical universities cooperate intensively, for example through the shared responsibility for a small number of Dutch "leading research institutes" in the field of technology created in the early nineties to support research in areas of particular importance to Dutch industry. In March 2004, plans to create a single Federatieve Technische Universiteit Nederland by 2010 were made official. A task force lead by former Dutch minister of Education, Culture and Science Loek Hermans where each of the three technical universities were represented by their chairman have discussed the future of technical education and research in the Netherlands, and come to the conclusion that strong coordination was in the common interest. Such coordination is at first to take the shape of a united "Virtual Technical University", where joint plans for education, research and knowledge valorisation activities are made and a shared organisation for each of these three areas of activity is created.

UT also takes part in a cooperation organisation created by European Consortium of Innovative Universities (ECIU). These universities are said to be "dedicated to the development of an innovative culture in its institutions, and to play a catalytic role for innovation in industry and for society at large". The ECIU Executive Board is the decision-making body of the association and meets twice a year. Chalmers was a founding partner of ECIU in 1997, but has since withdrawn from the cooperation. ECIU still consists of nine members, since Linköping University has joined the consortium. The ambitious goal of the of the cooperating universities stretches over education, recruitment of students, research applications to the EU and joint SME/University schemes for regional development. One example of cooperation is the master-level program "Innovative Entrepreneurship & Business development" offered in Twente. It is tied to ECIU, so that students of that program are encouraged to spend part of their time in education at another ECIU University.

Third mission approaches

Central activities directed by the Holding Company

UT runs a Holding Company, Holding Technopolis Twente, which is responsible for most central third stream functions. Earlier, the University also had a liaison group, but it was shut down as this approach to knowledge valorisation was considered too centralised. Large companies, it was believed, did not need a central unit to organize cooperation with the University, and for SMEs, the governmental organisation *Senter* was much more effective in establishing connections between firms and academic researchers than the UT itself.

The UT *Science Shop* is an attempt to organize small-scale knowledge diffusion. Students, or recently graduated students, perform research on behalf of individuals, groups, non-profit organisations and small companies, who otherwise do not have enough financial means to pay for scientific research. The UT states that the Science Shop yearly has about 80 customers.

Decentralised organisation of knowledge valorization support

The UT has a rather decentralised approach to third stream activitites. Each research institute of the UT has a "commercial director", or the equivalent thereof, responsible for industry contracts, alliances etc for that area of research.[21] There are also several examples of incubators at these institutes. The *Institute for Biomedical Technology* has direct connections to a Life Science Business Accelerator. The *Institute for Nanotechnology* (MESA+) - the largest research institute of the University of Twente - has a special program for cooperation with Small and Medium-sized Enterprises and hosts an incubator in direct connection to its' labs. The *Center for Telematics and Information Technology* (CTIT) has particularly strong connection to spin-off companies.

Academic unit for teaching and encouraging entrepreneurship

Research, teaching and practical education in entrepreneurship is combined at the Dutch Institute for Knowledge Intensive Entrepreneurship (NIKOS). NIKOS runs the Temporary Entrepreneurial Position program (TOP) for University entrepreneurs. The TOP-program started at the University of Twente when Professor Harry van den Kroonenberg started to support entrepreneurs in his own research group at his own expenses. Since this was successful, (financial) support was sought and found in the Ministry of

[21] The research institutes referred to here are large organisations with at least one hundred researchers and associated staff.

Economic Affairs. When van den Kroonenberg became Rector of the University, he supported the TOP-program and other entrepreneurial activities at the University of Twente.

During the first year of the program, the knowledge-based company is located in the University. After the first year they have to move on (ideally to the Business and Technology Centre-BTC and when they have grown too big for the BTC, they should move to their own premises on the Business & Science Park).

On-campus knowledge park

Situated on a single campus – an almost uniqe arrangement for a Dutch University – UT and the on-campus business and science park constitute an important entity in local and national innovation systems. 4000 people employed by some 200 companies work in the facilities of the knowledge park. In August 2004 the Province of Overijssel, UT and the city of Enschede signed an agreement describing how the three parties will collaborate on the development of Knowledge Park Twente. The agreement aims at producing ten thousand jobs by 2010 - twice as many jobs as those believed to have been created through the UT over the past fifteen years.

Lessons from Twente

Strategic ambition to concentrate activities

As the volume of scientific knowledge and the number of scientific study areas continue to increase, it becomes exceedingly difficult for a single University to encompass all promising and exciting fields of science. Even the strongest and largest universities are faced with the challenge to make strategic choices about their research portfolios. As advocated in Twente, the incentives for active portfolio management may be all the more important for a small University with ambitions to build and retain a strong research base. The ambition of the Twente management team to concentrate research activities to three fields – although broadly defined – can be seen as a challenge to all universities struggling for research excellence.

Alliance a tool to handle strategic risk

A University is traditionally thought of as an organisational entity where scholars of different disciplines and traditions work together and, at least occasionally, exchange views and ideas that enrich future research. For students, the University is often seen as a buffet of knowledge, where courses and disciplines of different nature can be found and combined in a way that suits interests and demands from employers. How, then, can UT imagine a

future as a University with research (and therefore research-based education) only in selected areas? And even if concentration indeed does lead to research strength, what happens if the chosen research portfolio looses its' attractiveness in today's fast changing world of science and technology? For UT, the concentration strategy clearly conveys risks, which need to be managed. How can a University do that?

Part of the answer from Twente, as given by the University management, is the proposed changes to the Dutch system of technical universities. Since 2004, an alliance between the three universities is being constructed. The goal is "a single federative University" by 2010. As a part of this alliance, research, education and knowledge valorization activities are being reviewed and coordinated. For UT, the alliance with the two larger and stronger universities is seen as a chance to manage concentration risks. As part of a greater, more integrated whole, the University sees itself more free to specialise and to develop a clear profile of its' own.

Institute form beneficial to commercial relations

The Dutch organization of technical research is worth recognizing. All three universities have a matrix-organization, where responsibility for education and personnel is concentrated to faculties and research is organized in virtual organization called "research institutes". At management level in Twente, this organization was motivated by a strategic need to create scientific focus. However, the institute form also seemed to be beneficial for working with industry in several ways. First, the cross-disciplinary approach makes it possible to focus on application areas rather than academically delimited disciplines. Secondly, each institute is headed by executive officers, of whom several have industry experience. Thus, industry can find one-point contact partners who "speak the language of industry" and have a sufficient mandate to make commitments for the academic side. Thirdly, the institute organizations can be given enough inertia to allow for risk taking and strategic initiatives. An example is the ability of the Institute for Biomedical Technology to acquire a research division from a company. The deal provided the institute with 15 researchers with industrial experience as well as a long term relation with the company.

Facility sharing: a win-win situation if managed properly

The large nano technology research institute MESA+ is one of the most successful parts of the University of Twente. A central strength in the experiment-intensive world of nanotechnology is the lab facilities of the institute; the clean room and the Central Materials Analysis Laboratory. Lab milieus are as important for commercial development as for research, and since most of the equipment is expensive and rare, labs are also a strong

connector between these worlds. Half of the 25 small companies currently situated in the incubator environment on the institute grounds have their roots outside UT. The facilities make out a large part of the attractiveness of the Twente location for these firms.

At MESA+, agreements on facility sharing are common and even though conflicts occur, all parts have realised the common benefits. For the academic researchers, the incomes from firm rents are recognised as vital to keeping the expensive labs running. For firms, access to specialised equipment is crucial.

Having firms and research groups work side-by-side also has interesting effects, such as promoting cooperation and affecting the culture of the research environment. Through everyday contacts, commercial thinking is introduced in a natural way.

Appendix V: Technische Universiteit Delft

Background and description

TU Delft is the largest, oldest and most prestigious of the three Dutch technical universities.[22] The second largest University, in student numbers, situated in Eindhoven seems to be steadily gaining on TU Delft in size, but the older University is still some 50% bigger than its closest national competitor. With a student body of more than 13,000 and almost 5,000 employees, TU Delft is also one of the largest universities in the Netherlands. Each year, the University's cumulative research results in an average of 185 PhD dissertations and over 4,000 publications in scientific journals.

The Polytechnic in Delft was set up in 1842 to meet the increasing demand for technically trained people, as it was felt that the Netherlands lagged behind its neighbouring countries from an industrial point of view. Today, the TU Delft is the largest employer in Delft and ten percent of the town's 100,000 inhabitants are students. The presence of the University has over the years attracted a number of technology-oriented companies to set up businesses in Delft.

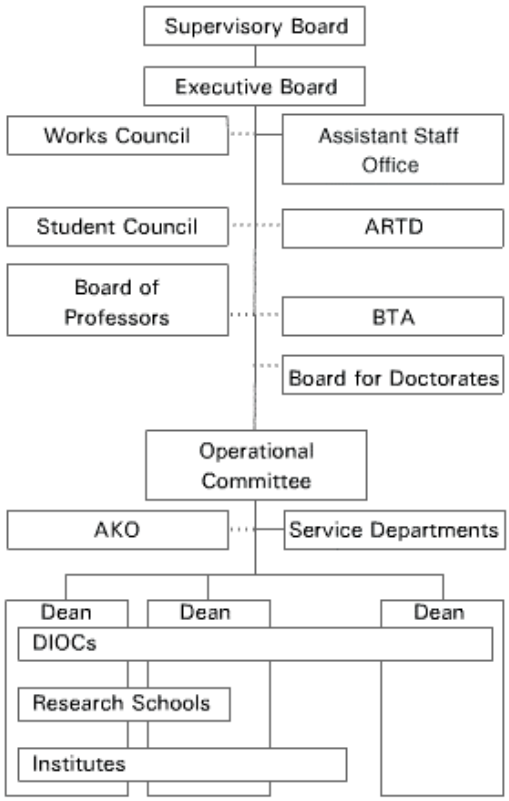
The University is strongly concentrated to technical disciplines, where aerospace and landscape engineering are particular hallmarks of the University. Technology associated with the Dutch struggle against the Atlantic for land is the particular twist of the latter area. TU Delft also has a special emphasis on architecture; in fact the discipline is the single largest area of study of the University.

Organization

TU Delft has a traditional University organisation, which emphasizes the decentralised nature of academe. Undergraduate education is divided into eight faculties, each lead by a dean. Education of doctoral students are organised in eight research schools and research in twenty research institutes – across faculty borders. The research institutes are organised after problem areas, which makes them suitable for research motivated by technical

[22] Technical higher education is in the Netherlands essentially performed by practically oriented Universities of professional education (Hoger Beroepsonderwijs) and by three academic, research-oriented universities situated in Eindhoven, Delft and Twente. A small part (1-2% of all students) of Dutch higher technical education is performed at Rijksuniversitet Groeningen.

problems and able to match the interests of industry within a single organisational entity. The faculties are closer to academic discipline organisation.



Strong connections to Dutch multinationals

TU Delft has strong established links to Dutch industry. Some Delft research institutes cooperate intensively with Dutch multinationals Philips and Shell, particularly in areas such as semiconductor technology, nanoscience and chemistry.

The Philips Delft Design Center is an interesting example of how this cooperation sometimes takes very close forms. In the Center, three permanent Philips employees dedicated to design work alongside three Professors, two PhD students and two MSc students from the University.

One of seven Dutch Leading Technological Institutes, Netherlands Institute for Metals Research (NIMR), is based in Delft. The institute offers consulting services. NIMR is a public-private partnership between partners from the Dutch metals industry, the three technical universities and the Ministry of Economic Affairs.

International alliance through IDEA League

In October 1999, four technical universities of considerable reputation entered a strategic alliance under the name IDEA League. These were TU Delft, Imperial College London, ETH Zürich (Eidgenössische Technische Hochschule Zürich), and RWTH Aachen (Rheinisch-Westfälische Technische Hochschule Aachen).

The alliance is meant as a tool to develop strong educational programmes on the master-level, following the development of the Bologna-process, and aims at strengthening the competitiveness of the four universities in terms of international student recruitment and international funding. Currently, the alliance runs two mobility programmes: *Vertical mobility* and *Horisontal mobility*.

Both of these programmes are meant for students who whish to study at more than one of the IDEA League universities. The first of these two programmes is for students who wish to switch universities between the bachelor and the master level, and the second for students who wish to spend part of their time as master level students as guest of another IDEA League University. The programmes ensure that students are treated equally in all cases.

During the current, fifth year of work in alliance, the partnering universities have started working together more closely on partnerships with industry. IDEA League is also setting up common master courses, drawing on the combined strength of the four partners. The alliance has lead to increased ambitions such as collaboration on international activities and coordination and common discussions of issues such as scholarships, media relations, alumni activities and education development.

Reflecting upon ethics

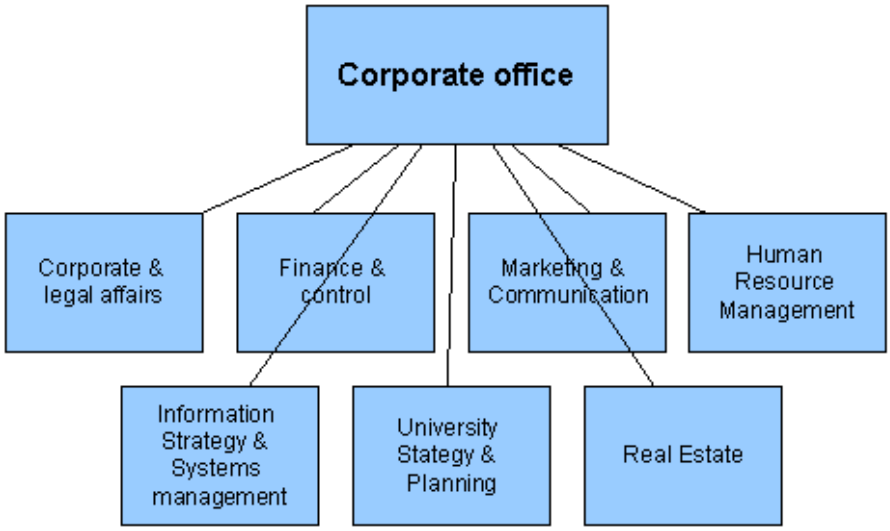
In 2004, TU Delft launched an initiative aimed at creating a broad discussion of ethical aspects of research. The project made serious attempts to engage Faculty in discussions about the effects that the University's collaboration with society – both indirect and through direct cooperation projects – were likely to have.

Third mission approaches

Central activities

Most central administration and monitoring of the University is handled by the University Corporate Office. Through intermediation of the Corporate Office, contract research is offered within the areas ICT & Multimedia,

Glass Treatment, Airport Development, Electronics & Mechanics, Ergonomics & Usability and Organisation & Process. Each of these areas is rather narrowly specified at the University webpage.



TU Delft, as so many other technical universities, offers special services, including recruitment, to Alumni and last year students, including a web-community and an alumni magazine with two issues per year. Non-profit recruitment services are offered by a separate University organisation called SUPAIR.

The University has a strong tradition of working with development projects in cooperation with developing countries. Such work is coordinated by a central unit called CICAT, which acts as a link between departments and international partners in developing countries. CICAT also, through its connections to Dutch education agency NUFFIC, assists academics from developing countries in finding grants from PhD och Master-level studies in Delft. CICAT has about 15 employees, of whom some work part-time.

Non-managed third mission

Many of the third mission-related initiatives - technology parks, incubators, support of academic entrepreneurship - found at technical universities are missing, smaller/newer or less emphasized at TU Delft than at many other, more entrepreneurially oriented universities.

Situated in the densely populated western Holland between The Hague and Rotterdam, the actual hinterland for TU Delft is a huge urban area, in which the University is but one actor among many. The “regional role” of the University and associated pressure to act as economic hub has therefore so far not been as accentuated as in many other European universities. The strong

funding from the state has also allowed TU Delft to stay relatively clear from some of the pressure that has caused other universities to undergo re-organisations and reorientations.[23]

The yearly 'Technology day' is seen as an important way to promote all kinds of relations between TU Delft staff, alumni and industry partners. By presenting research from different faculties, the University management states that productive relations between researchers working on related problems in different institutes or faculties are facilitated.

Deans adopt companies

TU Delft has not adopted the idea of corporate liaison programmes as a way to establish stronger connections to industry. Instead, each of the faculty deans is called upon to 'adopt' two companies. This model is clearly a representation of decentralised thinking and of the non-managed approach described above.

Lessons from Delft

Strong lab environments attracts partners, researchers

The facilities of TU Delft are a source of University pride. Supported by substantial, direct funding from the Dutch state, TU Delft has been able to build a number of strong laboratory environments. These assets should be seen as investments that heighten the attractiveness of the University as co-operation partner, securing the University's role as a hub for demanding R&D in certain areas. These investments also produce concrete income streams, as firms place research contracts with the University or co-finance investments that are of mutual interest. The University accounts for some 1200 contracts with industry.[24]

Offering the right conditions for SMEs

With different sets of ambitions, traditions and cultures, University-firm relations are never uncomplicated. Establishing conditions for cooperation between universities and small and medium sized enterprises (SMEs) is recognized as a particularly tricky problem for public and academic policy makers. A small firm typically finds it impossible to invest in large research projects that last for several years – both due to financial and operational constraints. The *ASTI institute* in Delft is an interesting example of an

[23] In 2004, over 80% of the total funding for TUDelft was received directly from the state. Only a very small portion of those funds were distributed under competition.
[24] These contracts may not all be very substantial, but some 35 new contracts per year are worth more than € 250.000.

attempt from the academic side to organise activities in such a way that co-operation with SMEs is made possible. The institute offers royalty based contracts, in which the firm agrees to share future profits resulting from a research venture with the institute. Behind the founding of ASTI lies the belief that cooperation with firms requires an organisational form able to act as a reliable partner, which can and is willing to make long term commitments. Royalty based contracts is but one way to manifest such commitment.

Appendix VI: The University of Surrey

Background and description

Surrey has frequently been described as the "rising star" of British academia. Founded in 1966, today over a third of Surrey's Faculty work in 5*-ranked departments, departments defined to work at a level of "international excellence" [25]. The University is particularly well known for its research in Electronics, Engineering, ICT and, increasingly, Medicine. The University teaches 11,600 students, 2,100 of whom are studying for higher degrees. It has 530 Faculty members.

The University has employed a series of charismatic and strategic leaders, each of whom has had a clear entrepreneurial, as well as academic, profile. The most recent Rector, Professor Christopher Snowden, has an excellent research background in microwave electronics and prior to his appointment at Surrey was Chief Executive Officer of Filtronic *ICS*. It is notable that the Rector of Surrey also styles himself Chief Executive Officer, this business title relating to the actual powers he has and the University's culture, which can be described as strongly entrepreneurial.

Engaging with Society

Surrey's roots as a technical college charged with developing "*the industrial skill, general knowledge, health and well-being of young men and women belonging to the poorer classes"* greatly influences the culture of the University today which can be described as not only positive towards industry and society but rightly proud of the strong links it has made. The University lists amongst it strengths "Commercial Awareness", an "Effective and Responsive Management Structure" and an "Academic range well matched to the perceived economic needs of the UK and Europe" illustrating the influence that business-like thinking has had on both its structure and activities.

Surrey collaborates with companies on campus and, notably, engages multinationals such as Nokia and Samsung in substantial research projects. Companies, and public agencies, appear to have input into curriculum development at Surrey as well, not surprising in a University that champions the "employability" of its graduates. This has produced strongly positive results with Surrey's students being the quickest to find full time employment in the UK.

[25] See http://www.hero.ac.uk/rae

Spin-off activities and SME interactions are also highly apparent on campus; Surrey owns Europe's most successful Satellite company, Surrey Satellite Technology. It works with sister universities in the south of England (Bristol, Southampton and Bath) to provide services for local SMEs, in particular in the form of continuing professional education.

Organisation

Surrey has a notably strong and *well resourced* management structure. The Vice Chancellor has a substantial Senior Staff of non-academics including a Director of Development and Director of Corporate Affairs, alongside more traditional posts such as Director of Finance and Director of External Relations. In this regard Surrey is very different from Cambridge, with the centre at Surrey having far greater strategic abilities. All Senior Staff report to the Rector, as does the Director of Research and, though him or her, the Heads of Schools, illustrating a compact and highly centralised management structure with clear leadership.

The University has a central strategy, "University Strategy 2004-2014", that outlines its research and other ambitions, including knowledge exchange. Each School also has a strategy, presented as Annexes to the main strategy of the University. Goals, milestones and metrics are worked in to each part of the strategy clearly illustrating Surrey's commitment to modern management techniques.

With historical roots in a 19th century polytechnic school, Surrey is still expanding its disciplinary scope. Today, the University has eight Schools, of which the Medical School is the most recent.

Surrey also champions cross-disciplinary Institutes in strategic areas initiating, for example, the Advanced Technology Institute to study integrated electronics to develop the cross-disciplinary activities that will be required to address the 'grand challenges' of the future in areas such as Nano-Technology, Wireless Multimedia and Media Imaging.

The University is at pains to stress that, despite its strong management structure, its academics are free to research as they wish. Surrey argues that its strong management is there to support and enable its academic staff, not to guide their work.

It is interesting to note that the Rector at Surrey has available to him special funds for recruiting excellence – either in the Universities management or in its faculty. Some 41 administrators and researchers receive salaries above £70,000, topped up by the University itself. This suggests that an active "star recruitment" strategy is in place at the University.

Third mission approaches

Surrey has a centralised approach to third mission activities, unsurprisingly. The Rector is clearly active in initiatives and dedicated section head, a Director of Corporate Services (non academic), reports to him. Corporate Services has under it nine sets of activities:

CORPORATE SERVICES
Alumni and Development Office
Business Support Services (Education)
Estates and Buildings
Human Resources
Improvement Programmes Office
Marketing and Public Affairs
Research Park
UniSdirect

Each of these is run by a non-academic professional. To ensure that good links are kept with Faculty, many of these offices have an advisory board from the faculty. It is not apparent that particular Schools have separate abilities; the centre provides.

A single office for industry interactions

The University has links with over 500 companies and a further 85 companies are based at the University-owned science park. Income from industry[26] in the year 2002-03 was £7M (94M Kr). The University established and manages an office known as UniSDirect. UniSDirect provides a gateway for industry to the University, as well as assisting the University to develop its third mission strategy with regard to industry.

Amongst services managed by UniSDirect are:

- Industry Research Collaboration facilitation
- Consultancy
- Support for Technology Transfer and New Businesses Start-ups
- SME support
- Continuing Executive and Technical Education

[26] Exact industry income will have to be further assessed, industry and "other" incomes are accounted for together in Surrey's Annual Report making the exact total unclear

It is notable that this office also actively promotes government initiatives to industry such as Knowledge Transfer Partnerships (collaborations between universities and industry on strategic, high-level research projects. The projects can be variable in length, lasting between 12-36 months, and aim to provide benefits for all partners involved) and the R&D Tax Credit. UniSDirect has dedicated personnel assisting faculty and industry access these types of award.

Lessons from Surrey

Growing research excellence in selected fields

As noted above, Surrey has developed an excellent research reputation *in some fields*. It is clear that Surrey has chosen to focus resources on selected areas of science and technology, most recently electronics, the life sciences and medicine. Surrey would argue that, as a smaller University in an increasingly competitive environment, these types of choice are necessary. Parallels can be drawn here with Lausanne, which has also made a series of strategic research choices. An ability to execute this strategy is no doubt related to the University's strong management structure.

Does this type of focusing, however, leave a University vulnerable? Surrey does not have the breadth of some universities and therefore has little ability to seed novel inter-disciplinary collaborations e.g. could Surrey address "Aging" as a research topic in an appropriately full manner? The University must therefore look outside of itself for emerging trends, constantly considering what it needs to add to its selection of disciplines to keep ahead. Perhaps though, this can be argued to be a strength as the University has to keep itself informed and relevant and is, therefore, more aware of its own skills an those of others.

Diverse Income base

Surrey has and income of £ 158.3M, gained from a very diverse set of income streams. Its accounts for 2003-04 show that direct government funding accounts for only 24% of income and competitive research grants (from the government funded Research Councils) another 16%, this meaning that 60% of Surrey's financing comes from external sources. 26% of Surrey's income comes from "Other" sources meaning income from industry collaborations, spin-offs, rents and facilities hire. Surrey's Foundation Fund, an endowment made up primarily of land that Surrey developed into a Science Park, produces a further 6% of its income. The remainder comes from academic fees with a staggering £18.8M coming from overseas students, mainly from Asia, alone. To put this in perspective this single income stream is larger that Cambridge's total income from industry. Indeed,

academic fees are Surrey's largest income stream responsible for 28% of income.

Whilst Surrey has been fortunate, having been granted land when it was started from the government, which has since become very valuable, it has also worked hard and in a focused manner to raise its own wealth. Its Science Park makes a little over £8M a year for the University. Surrey's actively supported satellite company makes a further £1M. Income from overseas students is also fought for and Surrey has put resources behind developing its international reputation and approach to handling international students. These types of privately owned income, of course, give Surrey the ability to invest in further activities.

What about the Faculty?

Surrey's active management model, both on a central level and within third mission activities, provides much to be admired. What of the Faculty? Have they been sidelined in Surrey's centralised strategy, becoming simply producers of research results? The University would argue emphatically "no". They state that academic merit lies at the heart of the University's success and that academic freedom lies at the heart of academic merit. It would seem, in fact, that Surrey does a remarkable amount to ensure that its researchers thrive.

As well as playing a direct role with industry, UniSDirect coordinates research support for faculty. UniSDirect hosts a database that describes expertise within the University. UniSDirect also assists with applications to funding bodies. A weekly funding bulletin is sent to all faculty and UniSDirect host a database of funding opportunities; staff at UniSDirect support researchers in making applications.

Alongside making funds available for "star recruitment" and investing £1.2M in rewarding a developing staff each year, Surrey is aiming to place *all* researchers on full time contracts. This is highly unusual in the UK and is a strong recruitment tool. UniSdirect's mission is "*Profiling, supporting and celebrating the role of people as the fundamental agents of knowledge transfer"* and it would seem that Surrey is good to its word; strong management is used only to enable a strong Faculty (in selected fields).

Appendix VII: The University of Cambridge

Background and description

Often described as Europe's leading research University, the University of Cambridge combines a commitment to fundamental research with an ever-keener interest in exploiting its knowledge. The University's strong academic heritage fosters an environment in which researchers are challenged to produce world-leading insights. Powerful in supporting this is the academic excellence Cambridge has achieved over all its disciplines; known increasingly for its Science and Technology, it should not be forgotten that Cambridge is a "full discipline" University, equally strong in the Arts, Social Sciences and Humanities. Trans-disciplinary research has long been a feature of Cambridge's working and is actively supported by its collegiate system. Today, Cambridge sees its roll as that of a global University, with more than half of all graduate students and Faculty coming from abroad.

Engaging with Society

Against a background of funding cuts in recent decades, and changes in the structure of British industry, Cambridge has not always found it easy to engage with Britain's economy. The University has however, since its foundation in 1208, produced a long line of political thinkers, scientists and business leaders who have played critical roles in developing the fabric of British, and international, society.

Since the 1970's *some* members of the University have actively sought to play a more direct role in the UK's economy, in particular spinning-off research results in to new companies. Concerted activities in this area, combined with Cambridge's research reputation, mean the University is now surrounded by one of the strongest science park clusters in the world. Whilst how active the University as a corporate entity was in the establishment of this cluster is sometimes bought in to question, it now works to support the cluster through initiatives such as the Cambridge Network that link it with local companies. Through the Cambridge Centre for Entrepreneurial Learning and Cambridge Enterprise, the University also teaches innovation skills to both its students and researchers, and directly supports researchers in spinning-off companies.

More recently, Cambridge also sought to formalise its relationships with industry, and other key research partners. Again, members of the University have cooperated with industry for many years; Rolls Royce, for example,

has based much of its jet engine research at the University since the 1950s. The University has not sought to hinder, or support, these alliances. Over the past decade however, it has become apparent to the University that it should value these links and provide professional support for forming relationships to its researchers. Cambridge's Wolfson Industrial Liaison Office, an embryonic office that formerly dealt with all innovation and industry issues, became the University's centralised Research Services Division (RSD) in 2000. A distinct Corporate Liaison Office was developed in 2001, this too merging with RSD in 2005. Today, 17% of the University's research income comes from companies. It is interesting to note that the majority of these companies are international with headquarters outside of the UK.

Organisation of research and education activities

In parallel to a typical School and Research Institute structure, Cambridge also has some 35 Colleges. As well as providing board and tuition to students, each College supports an academic community of Fellows. These Fellows are drawn from across all disciples at the University and are, in return for tutorial duties, given board and lodgings at the College. Colleges are seen as vital in promoting trans-disciplinary communication.

Cambridge has six Schools, where most academic staff are also employed and where responsibility for teaching is laid. Trans-disciplinary research is increasingly carried out through problem-orientated Research Institutes such as the new Centre for Advanced Photonics and Electronics (CAPE); these Institutes tend to fall under the (indirect) management of Schools. Many informal trans-disciplinary groups e.g. the Cambridge Interdisciplinary Research Centre on Ageing (CIRCA), can also be found.

With regard to University management, in line with University culture, Cambridge has a highly decentralised structure and, through the Senate, the academic staff of the University have the right to vote on most significant managerial decisions. Researchers were, for example, able to throw out proposals for IP reform put forward by the University. The University has no research strategy, other than to be the best in the world in the fields it engages in. The Vice Chancellor (UK equivalent to Rector) can *lead* the University but she has few powers, or resources, to manage it.

This structure has been seen as problematic as decentralisation makes it difficult for "the University", as a corporate entity, to have a voice and for strategic decision e.g. investments in further research centres, to be taken. However, Cambridge academics would argue that their autonomy is at the heart of the University's success – both in research and commercial terms. Faculty can define their own working environment and *have to* develop

entrepreneurial skills to succeed. In Cambridge the "Academic Entrepreneur", able to form trans-disciplinary alliances and sell his or her ideas to the funding councils or industry, flourishes. These types of skills, Cambridge argues, make its researchers successful in the commercial world too. It has also been felt however, that the University has not moved as quickly as others i.e. US Universities, to capitalise on its abilities. The development of a Clinical School to complement the Life Science research already undertaken at Cambridge has taken considerable time.

Third mission approaches

UK Innovation Policy

Though highly dependant on public funding, UK Universities have a tradition of autonomy and many have significant independent income from real estate and other investments. Relative financial and political independence means many UK universities have developed a capacity to act independently, both in terms of research and innovation activities. Several Universities took advantage of their independence to develop entrepreneurial activities well before the government actively promoted it e.g. the Universities of Surrey, Imperial, Manchester, Warwick.

In 1994 the UK government decided to fund a series of initiatives and programmes to support entrepreneurial activities *within* Universities. The Higher Education Funding Council for England (HEFCE) increased its funding for these so-called "third stream" activities to over 100 million pounds in 2004. Funds managed by HEFCE, such as the Higher Education Innovation Fund (HEIF) describe their aims as "embedding" an innovation culture in research institutes, broadening their capacity and reach, improving University responsiveness to business and community needs, and catalysing the social and economic benefits of University research[27].

In complement to HEIF, the UK government has a number of national platforms for promoting various types of collaboration between business and universities. *LINK* research programmes match corporate funding for research projects with government monies[28]. *Faraday Partnerships* bring together a number of research institutions and companies to develop a certain technology or technology area[29]. *CASE* awards fund industry-partnered PhD projects[30]. It is interesting to note that, despite these initiatives, UK companies are amongst the worst investors in R&D. As a share of gross domestic

[27] See HEFCE : Business & community
[28] See LINK, www.ost.gov.uk/link
[29] See Faraday Partnerships Initiative in the UK, www.faradaypartnerships.org.uk
[30] See Industrial CASE, www.spsrc.ac.uk

product (GDP), overall corporate spending on R&D in the UK has declined steadily over the last 20 years, in marked contrast to the trend in most other developed countries[31].

Cambridge benefits from HEIF funding (over one million pounds a year) and also heads several Faraday Partnerships as well as taking advantage of *LINK* partnerships where possible.

Management of Innovation Activates

Within the culture of Cambridge, centralised activities are always developed with great caution. As noted above, this has been the case with innovation support activities. Initiatives tend to develop around the periphery of the University, with support from interested parties, only being centralised when proved successful, or demand becomes such that they can no longer be left without support. There is a direct parallel here with the independence given to researchers and it can be posited that this approach has lead to Cambridge having an "Entrepreneurial Administration", as well as Faculty. It can also be argued that a lack of central commitment has meant that weaker than necessary support function have developed - and that much time has been wasted in chasing support and funding from within the University, as well as outside.

Cambridge Enterprise was established in 2003. It was created with the aim of bringing together spin-off and technology transfer activities. Cambridge's Challenge and Venture Capital Funds (seed funding), the technology transfer functions of RSD, the non-educational portions of the Entrepreneurship Centre (spin-off facilitation), and Cambridge University Technical Services (consultancy) were merged under a single organisation, Cambridge Enterprise. Cambridge Enterprise was established *within* RSD as it was thought that closer association would bring about commercial synergies, as well as economies of scale.

The *Corporate Liaison Office* was founded in January 2000 in response to the University's need to provide a clear mechanism for interaction with external organisations. *Whilst established within the University, the CLO was not a central initiative*. The office focuses primarily on building research – and other – collaborations with industry. It also plays a role in coordinating community activities and Cambridge and has a Research Strategy Unit that assists academics develop research themes.

[31] See the *Lambert Review* 2003 Lambert Review

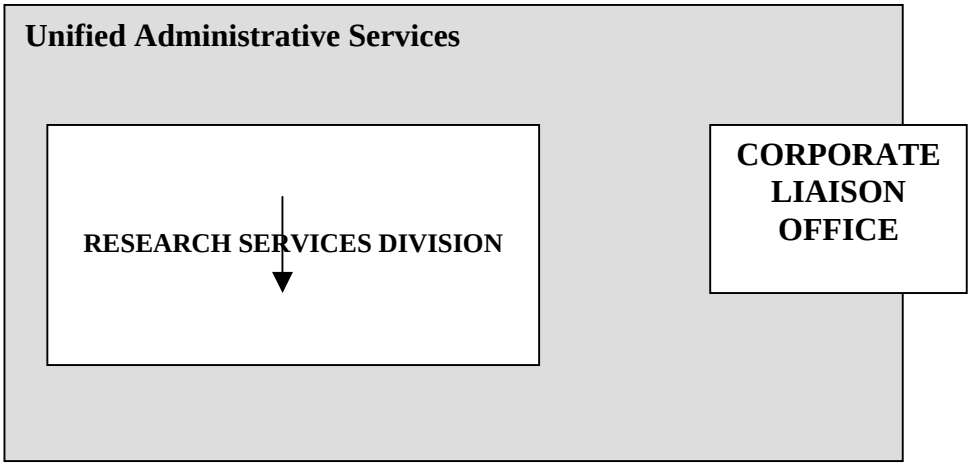


Figure 1 An illustration of the organisation of third stream activities in 2003

This structure was not seen as productive and in March 2004 the University established a Panel to review strategy, practice and organisation within innovation. The Panel decided that Cambridge Enterprise should be "spun-off" from the University, becoming a for-profit organisation, and that the CLO should be merged with RSD so that it could provide the relationship management skills that the group was lacking and so that this increasingly important area could come under central management.

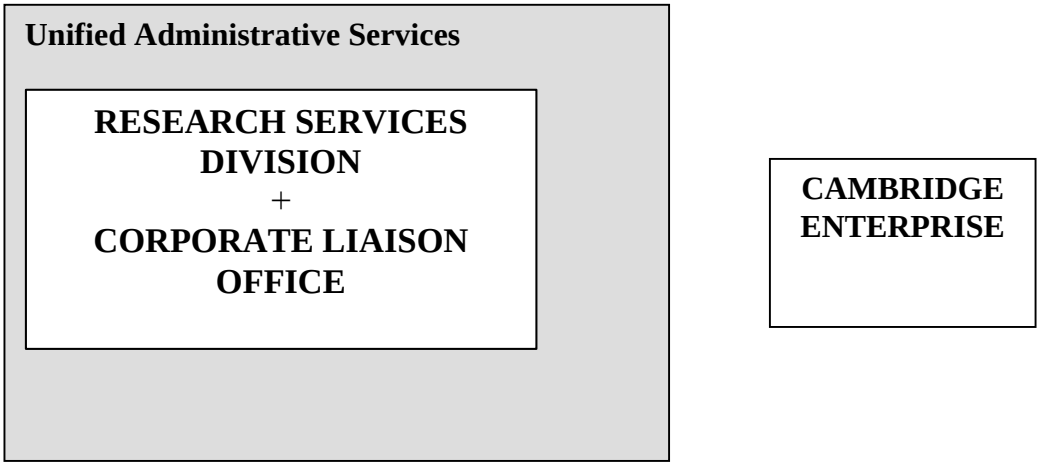


Figure 2 An illustration of the reorganisation of third stream activities

The new office is designed to be a "one stop shop" for building research collaborations will be called The Partnership Group to reflect the multiple actors it will work with. Cambridge Enterprise will operate "down stream" focusing on spin-off, consultancy and licensing activities. Other, wholly

commercial companies, will also be able to approach researchers to support the commercialisation of their work

Whilst centralisation is evident, it should be noted that several innovation functions still exist independently within the University. Several Departments have their own industry liaison officers, the Cambridge Programme for Industry runs educational courses for business leaders, as does the Judge Business School and the Institute for Manufacturing.

Lessons from Cambridge

Building new Research Collaborations, and Supporting a Global Reputation

A particularly successful initiative undertaken by the CLO (now Partnership Group) at Cambridge is the "Horizon" seminar series. In the words of the series brochure, the seminars "bring together leading academics and industrialists to challenge disciplinary frontiers and explore novel application". The seminar series was launched in 2002. In 2005 seminar topics include:

- Technology: Interaction and Design
- Personalized Medicine
- Cities of the Future
- R&D – Beyond Einstein

These "early stage" seminars serve two purposes at the University. They of course allow the University to communicate the excellence of its research in certain areas to industry leaders, but perhaps more significantly, they provide an opportunity for a group of researchers to get together and explore ways to further research in this area. The seminars have become a surprisingly powerful bottom-up tool for seeding and developing trans-disciplinary research collaborations, as well as a marketing tool. It of course helps to have potential industry partners involved in early stage discussions.

Over 400 different companies have attended the seminars, with an average of approximately 100 attending each event. Whilst the University targets large multi nationals in key R&D sectors as (paying) guests, it also makes sure relevant SMEs from the Cambridge Cluster are invited. The seminars create, therefore, a unique networking environment bringing together leading researchers, industrialist and entrepreneurs.

Networking for Success: local, regional and international activities

The Chancellor of the Exchequer (UK Finance Minister) initiated the much-discussed Cambridge-MIT Alliance in July 2000 with an award of £65 million of government funding over 5 years. It is a collaborative alliance between the University of Cambridge and Massachusetts Institute of Technology established with the goal to develop joint education and research initiatives that will improve entrepreneurship, productivity and competitiveness in the UK.

The Alliance has been a useful learning experience for the Universities, both in terms of entrepreneurship and in managing large-scale alliances. CMI is seen as having had a very positive impact on educational activities at both universities. In particular CMI Enterprisers, a weeklong programme aimed at undergraduates close to the completion of their degree, has had a highly positive impact on raising confidence levels, whether they go on to work in industry or stat companies. Cambridge has also encouraged more students to spend time with research groups whilst MIT has engaged in Cambridge style one-to-one supervision of its students.

The Alliance has had teething troubles but has dealt with these robustly. Research project funding at the start of the project was awarded to many, small projects. Whilst this raised levels of engagement, it was costly and inefficient over the substantial physical distances involved. From 2003, CMI supported fewer, lager projects, projects deemed strategic to the economies of both nations.

CMI also has a remit to distribute its knowledge and learning across the UK. Often more comfortable with its global role, Cambridge has struggled to find significant advantages from national alliances. Two exceptions to this are a “Proof of Concept” fund it has initiated with Oxford and Imperial to foster the development of research initiatives into companies, and i10, the organisation through which Cambridge collaborates with Universities in the East of England region. In particular i10 has helped Cambridge develop an interface with regional industries and the University has seen advantages from not responding alone to the needs of these diverse groups.

As noted above, Cambridge also fosters links with local high tech industries through the Cambridge Network and today plays an active role in the development of the Cambridge Cluster. Representatives of the Cluster also support the University, for example, helping manage its venture capital funds and mentoring students who wish to start companies.

Again, the decentralised structure of the University has made it difficult for it to champion alliances. Other UK Universities e.g. Nottingham, have gone on to form Alliances and build campuses in China. It can be argued that Cambridge, like other highly successful universities, has little immediate need of this type of activity. The many positive experiences gained from the alliances Cambridge has entered suggest this not to be the case. It is cheering to hear that the University is considering forming a "Development Alliance" with Universities in Africa to support education and leadership in the region.

Getting it right at the Department Level

A positive result of Cambridge's decentralised structure is the clear responsibility departments have taken for developing their own innovation and outreach activities. A strong example of this was seen by members of the study visit at the Cavendish, Cambridge's Department of Physics. The Cavendish was of particular interest because disciplines like Physics are sometimes seen as further away from the innovation agenda than Engineering, for example.

The Cavendish has managed to combine a commitment to academic excellence with substantial achievements in innovation and outreach.

Professor Malcolm Longaire, Head of Department, bought to KTH's attention the many events the department runs for the public, focusing in particular on schools children. The Department has a dedicated "Outreach" function that runs events such as "Physics at Work", together with industry, designed to increase children's awareness of the application of physics in the world. Each of these events attracts over 350 school children. The Department also supports, and provides resources for new school Physics teachers. These types of activity are seen as critical for developing a long-term interest in Physics in school children, thereby ensuring the development of the discipline as a whole.

The Cavendish is also confident about working with industry on R&D projects. Both Hitachi and Toshiba have own-staffed labs in the Cavendish and close relationships with researchers. Whilst the Cavendish is careful to "ring fence" these companies so there is no loss of IP, it enjoys their presence valuing the market perspective, equipment and funding the companies bring. The companies have learnt from the University in other, non-research ways too, for example, Toshiba, have just spun out a company, Teraview, from research it conducted whilst at the Cavendish, preferring this "Cambridge Innovation" route to taking the technology back to Toshiba headquarters. Indeed, the Cavendish has become well known for spin-off companies.

Plastic Logic, Cambridge Display Technologies, Cavendish Kinetic and Teraview are just some of the companies based on Cavendish research.

Whilst successful in these "third mission" areas, the Head of the Cavendish emphasised that academic excellence is the only criteria for recruitment and promotion. He argued that those who have achieved excellence in this area are often able to transfer skills to achieving in other fields, whether public outreach or business. This recruitment policy, Professor Longaire argued, was critical to the long-term health of the Department, and science; industry relations, commercial opportunities and public respect will come *because of* good science and are no substitute for it.

Appendix VIII: EPF Lausanne

Background and description

Technical education has been offered in Lausanne since 1853, for many years as part of the local University, run by the canton. In 1969, the technical faculty was given status of independent federal University under the name École Polytechnique Fédérale du Lausanne (in German ETH Lausanne).

Transformation and growth

Recently, EPFL has undergone transformation processes dealing with both geographical and organizational issues. On January 1st 2002, the 12 departments were replaced by four schools and simultaneously, all activities were moved to the main campus. Since the beginning of 2004, the whole of the EPFL is situated on one single site in a Lausanne suburb. The number of schools has increased to seven. Volume indicators of the EPFL also show signs of rapid change. Student numbers are up 60 % since 1990 and the number of doctoral students is up 160 % for the same period.

Reputation on the rise

In the last few years, EPFL has acquired a reputation as something of a rising star of the Swiss University system. This position is partly related to the trend towards generally higher entrepreneurial activity in the French-speaking western part of Switzerland than in the German-speaking east, with the EPFL as an important hub for start-ups on a technological basis.[32] EPFL research quality is also increasingly distinguishing itself. The scientific set-up of is traditionally to quite a large degree transdisciplinary.

Compared to the only other Swiss technical University, the ETH Zurich, EPF Lausanne is still more concentrated towards education. Still, the concentration of doctoral students / undergraduate student is about the same, if not slightly higher than that of KTH.[33] In a Swiss ranking of higher education, EPFL ranks lower than ETHZ for most Architecture, Engineering and Computer Science educations, but higher in the areas Chemistry, Physics and Mathematics. In terms of education profile, EPFL is strongly oriented

[32] See www.swissup.com.
[33] Numbers taken from KTH annual report and Swedish official data of National Agency for Higher Education (HSV).

towards the engineering sciences and towards computer sciences in particular.

Organization

EPFL has four vice presidents, of whom one is responsible for academic affairs, one for knowledge valorization, one for international affairs and one for planning and logistics. All non-academic organisations of the University are organisationally tied to the respective vice president secretariats.

Third mission approaches

EPFL has a strong reputation for third stream support, and the seed-capital-activities and encouragement of entrepreneurship are by some experts considered to be best Swiss University practise. EPFL third mission activities are lead and coordinated by the vice rector for knowledge valorization and innovation, Professor Jan-Anders Månson.

There are two central University units belonging to his organisation. The industrial relations office (SRI) with seven employees has a supporting role for legal issues – both towards departments and start-up companies – and responsibility for IPR strategies. The unit also negotiate sponsored research and technology transfer agreements. In 2002, the office registered more than 200 research agreements and 27 license agreements. 40 patents were filed and 10 start-up companies created. The trend has since then been an increase on all fronts.

The unit CAST, consisting of eight people, runs the Industrial Liaison Programme of the EPFL, which has been going on since 1986. The APLE (Association pour la promotion des liaisons EPFL) was created at the same time in order to gather all the companies affiliated to the program. The Cast-EPFL's mission is to inform the APLE's members about EPFL's opportunities and assist them, whenever necessary, in order to maximize their interaction with EPFL laboratories.

The EPFL Science Park on the campus currently hosts 102 companies. Companies who move into the park must be able to show strong synergies with the laboratories of EPFL, other universities or other business park companies. The companies have 12 months as of their establishment to show such synergies.

Lessons from Lausanne

Clear view of support system

At the time of our visit (spring 2005), EPFL had recently created a position as vice rector for innovation and knowledge valorization. The newly appointed Professor Jan-Anders Månson was just starting to organize his ideas for a reform of the EPFL innovation support system. The systematic approach of the vice rector struck the delegation as exceptionally useful for analyzing, coordinating and communicating University efforts within the field. To create a simple scheme of activities within in the innovation support field can be a simple but effective measure to improve third mission work.

Attractive projects a possible catalyst

Some of the projects showcased at the EPFL did in themselves leave a strong impression on the delegation. The Alinghi project, where EPFL researchers teamed up with industrial partners to achieve a rather attractive goal (win America's cup) or the long-term EPFL effort to create a solar-driven aircraft are both examples of how large projects with a clear, exciting goal can serve as a catalyst for cooperation between academe and industry, and between different academic disciplines. Extraordinary challenges such as these projects, where scientific knowledge is applied to a clear, visionary task are, needless to say, also very useful for the communication efforts of all partners.

An ability to act entrepreneurial

When visiting the newly created Brain and Mind institute (BMI), the delegation was inspired by the drive and strong commitment made by the EPFL to take a position within the life sciences. A strategic overview showed that it would be possible to bring together existing research groups to form a basis for an initiative in a new and "hot" research area: the study of the brain and the human mind. To build the new institute, a leading researcher was recruited and substantial funds were made available to afford first-class laboratory equipment. The creation of the BMI was a substantial investment by the EPFL, made in an entrepreneurial spirit. Through building a strong position in an attractive area, the institute has attracted industry funding, some of which pours over on other departments. A very recent example is a prestigious deal with American software giant IBM, which gives EPFL access to the most advanced computer technology available as well as direct funding. To act entrepreneurial – i.e. to identify opportunities and act accordingly – is the hallmark of any great scientific group. But in creating the BMI, the EPFL showed entrepreneurial abilities at the University level. Such abilities are unfortunately not a hallmark of all great universities.

Appendix IX: ETH Zurich

Background and description

The history of ETH Zurich stretches back to 1855, a year that saw the opening of a technical school in Zurich called *Eidgenössische Polytechnische Schule.* This polytechnical college was intended to serve the needs of the entire Swiss federation, a much debated new way to organize educational matters in multilingual, strongly federal Switzerland. The present name of the University, *Eidgenössische Technische Hochschule* (ETH), dates back to the reorganization of 1909. Education at the ETH, which 'til then had been directed at scholastic learning, was shaped after academic traditions and the school was given the right to award doctoral titles.

Elite ambitions

ETH Zürich has an established reputation and is by many considered an elite University. This renown is in part due to the twenty Nobel Prize winners who, with a particular concentration to the 1930s, 40s and 50s, are associated with the academy. The stated ambition has for a long time been to compete with the best technical universities of the world. As at many renowned universities, ETH tends to be comparatively concentrated towards research in the balance between research and educational activities. It can, for example, be noted that the concentration of doctoral students / undergraduate student is almost twice as high at ETH as it is at KTH. Together with three other technical universities of some reputation (Imperial College, TU Delft, RTW Aachen), ETH formed the IDEA League alliance in 1999. The league has stated stimulation of mobility and cooperation on master-level education as a primary objective. So far, the main results are however exchange of views and cooperation at University management level, as well as possible branding benefits.

Breadth and internationality ETH hallmarks

A relatively large share of foreign students has long been a hallmark of ETH. In 2003, 11 % of the undergraduate students and more than half of the doctoral students were foreign citizens (at KTH, the approximate corresponding numbers are 7% at the postgraduate and 11 % at the doctoral level[34]). These high mobility rates are in part explained by the vicinity and

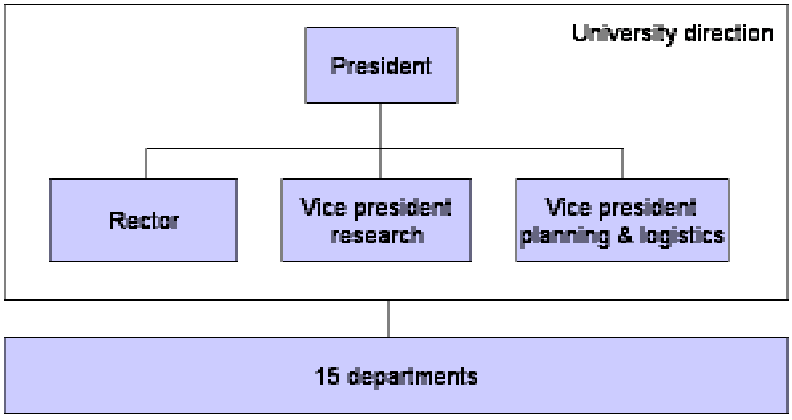
[34] Numbers taken from KTH annual report and Swedish official data of HSV.

non-existent language barrier to Southern Germany[35], but the attractiveness is surely also connected to the renown of ETH and to the central European location of Zurich.

For a European polytechnic, ETH has a comparably broad disciplinary scope. Besides engineering sciences, particular emphasis is placed on natural sciences. A characteristic of ETH is the activities in applied sciences such as earth, environmental, agriculture and food sciences.

Organisation of research and education

ETH is run by a direction of four people. The executive power is that of the President (currently Dr Olaf Kübler). The Rector is responsible for education and has the overarching responsibility for academic affairs. There are also two vice presidents and three pro-rectors. The vice rector responsible for research is also responsible for cooperation with industry. Education and research at ETH is organized in 15 departments, each lead by a director.



Third mission approaches

Organisation for technology transfer

The vice president for Research has a staff divided into four departments. The departments of *Research Coordination* and *Euresearch* both support and coordinate research projects and scientific infrastructure on the University and international level respectively. The other two departments, *ETH Transfer* and *Strategic Projects*, both to a certain degree support research projects where ETH staff cooperates with industry, governmental organisations and/or NGOs.

[35] although many Swiss accents are problematic for Germans, only traditional *Hochdeutsch* is traditionally spoken at ETH, as in most other Swiss universities.

The department ETH Transfer acts as a contact central for faculty seeking support for industrial cooperation, inventions, patents and licenses or company foundation. ETH Transfer also reaches out to companies, offering intermediation services.

Internationally, ETH among other things participates in a cooperation network consisting of some 150 German research institutions with transfer functions. This network offers access to academic contacts for interested industry partners. ETH is also active in a national network; *Schweizerische Netzwerk für Innovation*.

Contacts students-industry

The student union, which is active both at the ETH and at the University of Zurich, organizes lectures, interviews and a yearly employment fair, where students and companies get the opportunity to make acquaintances. There are also similar contacts between the student organisations of the different educational programs and companies with an interest in the respective field.

Recently, ETH has added another initiative to list. The alumni department has introduced career service for students and alumni alike. This function is based on familiar patterns, with a mentor program, counselling and intermediation of jobs and apprenticeships.

Encouragement of entrepreneurship

In 1996, the first regular course in starting a business was held at ETH. The lectures became very popular and courses on such themes are still held, nowadays organized by an independent firm founded for this purpose. ETH cooperates with the University of Zurich in most issues concerning the encouragement of entrepreneurship.

Fund raising initiative launched

Fund raising for universities on a serious scale is still a phenomena exclusively existing on a few successful American universities. ETHZ is one of few European universities that consider it possible to actually establish a significant foundation capital through endowments. In 2003, a foundation for this purpose was introduced. The stated strategic purpose is to increase non-governmental founding of the ETHZ. The *ETH Foundation* shall “support strategically important projects and the international competitive ability of the University”.

IBM a major industry partner

US corporate giant IBM has a large research facility in Zurich and is a key partner for the ETH Zurich. There are many examples of co-funded research in the form of consortia, research centres or co-financed conferences. IBM also hosts ETH students for special projects. Such funding has been known to include financing doctoral students as well as sponsorship through access to advanced IBM equipment.

One example of IBM / ETH collaboration is the Zurich Information Security Center (ZISC). Formed in late 2003, ZISC is run by an ETH-led industry consortium comprised of Swiss banking giant Credit Suisse, IBM's Zurich Research Laboratory, and Sun Microsystems Laboratories. More recently, the federal department of defence has joined the consortium.

Lessons from Zurich

Strong communication a necessity for the entrepreneurial University

Communication is an ability that has been added to University functions rather recently. The communication tasks performed by ETH Zurich resemble those of KTH, as well as most other large universities in terms of scope. At ETH, communication efforts are however clearly impressive in terms of scale and professionalism. With 36 employees, the Corporate Communications office is able to act as strongly and as a multinational company, offering 24h press service, large science fairs, etc. The office also runs a daily electronic newspaper. Since the launch of *ETH Life in* 2001, the editorial office of seven journalists have published news, portraits, debates, articles and so forth, all with clear focus on current activities at the ETH Zurich. ETH Life is also available in an international, English edition. In all its efforts, the office has a central message that it seeks to communicate: that ETH Zurich is “a leading research institute working for “the world for tomorrow”. The penetrating power of this message is seen as vital for ensuring beneficial relations to firms, potential students and employees and, not least important, the Swiss taxpayers who finance the University through federal taxes.

Entrepreneurial approach to raising funding

Switzerland is the richest (per capita) nation on the planet. The two technical universities are the only ones run by the federal government, and are thus resting on a very strong financial basis. But even in this strong climate, funding is increasingly insufficient for the perceived needs. Failing public funding is a common situation for most if not all of Europe’s older academic

institutions. One of the responses of ETH Zurich does, however, shows extraordinary entrepreneurial ambitions. Through the creation of the *ETH Foundation*, the University hopes to create a fundraising activity of American proportions. The foundation is run much like a wholly-owned company with the task of raising funds for ETH Zurich. This is seen as highly positive for the culture and working practices of the Foundation; it is able to pursue goals and targets in a manner that is atypical within a University culture. If successful, the ETH Foundation will set a strategically important precedence for other European universities.

Tech transfer is a culture transfer

Zurich and Stockholm may be regarded rather similar in terms of culture. As somewhat conservative environments, economically dominating their respective countries and in their turn dominated by large, multinational companies with roots in the nineteenth century, both cities have long experience that entrepreneurship and the founding of new firms was not held in much esteem. Today, there are indications that winds of change blow in Zurich, and that the ETH has played a role in this change. In 1993, Zurich followed a trend that had blazed through Europe's University cities in the 1980s and established the *Technopark* with close links to ETH. In interaction with each other, Tech Park and University have brought about something of a cultural revolution with respect to entrepreneurship, affecting both the University and the founder site Zurich as a whole. Recognizing that transfer of technology from the academic to the commercial world is a transfer of culture, the people behind the Technopark have worked with cultural issues from the start.

The philosophy behind this work is not that all technologies and far from all researchers shall cross the border between academe and industry. But positive role models, limited cultural barriers and a recognized platform for entrepreneurship will create better conditions for continuous flows between academic activities and commercial ventures. Many universities are still more active in the field of entrepreneurship, and many cities are more permeated with entrepreneurship spirit than Zurich is. But change is underway, and the efforts at ETH and in the Technopark are inspiring examples of how a University can start to reshape a region.

Appendix X - Institutional Metrics

The EFP approach - learning from the experience of others – bears resemblance to methods known as benchlearning. Such methods emphasize systematic studies and organizational learning. As a complement to these studies, we have found it valuable to undertake a limited benchmarking exercise. This exercise aims at providing a deepened understanding of conditions at the studied European universities, though systematized and comparable metrics.[36]

Data sources

Producing comparable data on institutions in different national systems and contexts is never an elementary task. The account below is concentrated to areas where we believe that reasonably comparable data, in spite of difficulties with definitions and delimitations, can be produced.

The main sources of data are the 2004 annual reports of the reviewed Universities and similar "facts and figures" material – either printed or on websites - produced by the Universities. To determine educational profiles, complementary data has been gathered from University homepages to determine the approximate content of certain educations. Data on the National systems for higher education has been gathered from a 2002 OECD study (see note 24) and complemented with information from government homepages of the respective countries.

Ranking lists

Ranking universities is an area of great controversy. Can places of science be ranked at all? Does it make any sense to compare achievements in totally different disciplines? Are the included measurements really covering the most central aspects of University research? Still, rankings are more popular than ever. To explain this interest, we probably don't need to go further than to familiar trends such as increased internationalization of education and science funding and the increased interest in universities as regional powerhouses for the knowledge economy. And regardless of how one deems the validity of rankings, they play an increasingly important role for the international brand name of a University, and consequently for such important

[36] We have chosen to not include MIT to avoid involving discussions about comparisons between European and US conditions.

matter as the interest of potential industry partners, foreign students and Faculty.

Below are results from two of the most frequently quoted global rankings. A first validation of these rankings is that universities considered prominent, such as Harvard, Cambridge, Stanford, Berkeley and MIT, appear on top positions. Compared to the six European Universities, KTH is doing moderately.[37] Looking at previous rankings, results are relatively stable for all universities apart from that KTH has fallen significantly and EPFL has risen. EPFL and Delft are much better ranked in the TIMES Survey, which makes more use of recent citation data.

	Shanghai index (2005)	TIMES top 200 (2005)
Cambridge	**3**	**3**
ETHZ	**27**	**21**
EPFL	**153-201**	**34**
Delft	**203-300**	**53**
KTH	**203-300**	**196**
Twente	**301-400**	**-**
Surrey	**401-500**	**-**

Educational profiles

An important criticism of University rankings is that they try to compare the incomparable: different fields of education and different disciplines of scientific research. In a parallel way, we believe that findings on innovation and outreach activities must be related to the academic profile of a University, a faculty of technology can for instance be expected to have better premises for attracting industry financing than a Faculty devoted to humanitarian sciences.

Surrey has its roots, and its most prominent research, in the engineering tradition. However, the University has actively sought to broaden its disciplinary scope. Today, the University has a large education activity in basic courses in business and economic subjects.

Cambridge is a full-discipline University with a strong dedication to arts and humanitarian sciences.

TU Delft emphasizes the technical nature and purpose of education in natural sciences and economic subjects. There is a strong concentration on

[37] It can be noted though, that of the four universities with long histories (Cambridge, ETH, Delft and KTH), KTH is doing less well.

architecture, and among engineering disciplines, aerospace and landscape engineering are hallmarks of the University.

Universiteit Twente has an emphasis on engineering education, but is also active within business administration and some social science/humanitarian fields, such as cognitive science and philosophy.

EPFL has a strong concentration in traditional engineering sciences, including computer sciences and applied natural sciences. The natural sciences are smaller in absolute numbers, but are rated higher than ETHZ by a national ranking (ETHZ ranks higher for most other disciplines).

ETHZ has a broad education profile, where applied sciences such as forest science, agricultural science etc are particular characteristics. Engineering sciences are particularly known for high quality.

KTH has, just as Delft, Surrey and ETHZ, a long history as a polytechnic. Traditional engineering sciences and (applied) natural sciences dominate the education agenda.

	Architecture	Basic (natural) science	Engineering sciences*	Computer sciences	Civil and Environmental Engineering, geomatics	Business studies / Economics + law	Arts & Humanitairies	Medicine	Social science	Other applied sciences
Surrey		√	√	√	√	√	√	√	√	√
Cambridge	√	√	√	√	√	√	√	√	√	√
TUDelft	√	√	√	√	√	√				
UTwente		√	√	√	√	√		√	√	
EPFL	√	√	√	√	√	√	√			
ETHZ	√	√	√	√	√	√	√			√
KTH	√	√	√	√	√	√	√		√	

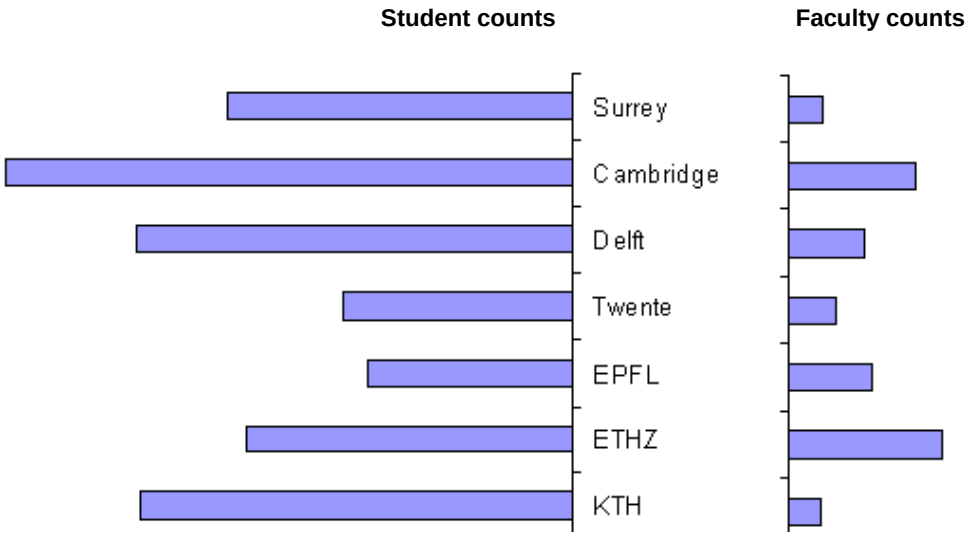
Interpretation Guide

Dark blue: ≥ 25 %
Blue: 25 % > ≥ 15%
Light blue: 15% > ≥ 5%
Grey: < 5% of the number of total students

Basic (natural) science: Mathematics, Chemistry, Physics, Biology/ Life sciences
Engineering sciences: Mechanical engineering, materials science, electrical engineering, industrial design
Other applied sciences: Agronomy, Forest science, Geology

Student and Faculty counts

The scale of the different institutions is the key to interpret the above data on educational profiles, especially when comparing oneself to large institutions such as the University of Cambridge. We also want to describe the institutions in terms of their number of Faculty.



Looking at student numbers, KTH is with some 14.000 registered students a relatively large institution in the circle of seven studied Universities. Counting the number of Faculty, however, KTH comes out as the smallest of the seven.[38] This relationship seems to point at a difficult position for KTH and, indeed, for Swedish higher education in technology in general.

Frameworks of national University systems

Traditionally closely linked to the state, each European University is still in many ways strongly influenced by differing national systems. Some of these frameworks should be reviewed, as they give the studied Universities a separate set of possible actions. For example: rights to own property and charge student fees (at least for non-EU students) are given to Universities in all of the four compared countries, except Sweden. Another part of the national framework is the number of universities to whom the national authorities have given the right to award the highest degree in basic technical

[38] Faculty numbers are denoted in Full-time equivalents, since this (more interesting) measure is available for all studied institutions. KTH has a Faculty of about 1000 full-time equivalents.

education (comparable to the Swedish title of *civilingenjör*). In Holland, with its population of 14 million, three Universities have this privilege, in Switzerland only two. It is hardly a coincidence that these Universities have stronger financial support from the national government than either one of the seven Swedish technical Universities / technical faculties with the rights to award the *civilingenjörs*-degree. Other examples of national priorities are the special legal status of the two Swiss technical universities and recognition of special status for Cambridge and Oxford in the UK.[39]

TU Delft / U Twente: The Dutch system for higher education is allowing more freedom to universities than any comparable European country.[40] The only significant constraints regards the right to start new educational programmes (must be approved by the government and by the accreditation authority) and to decide on level of tuition fees (only for part-time studies).

ETHZ / EPFL: Flexible system with a special law and a particular government body for the two technical universities and the technical institutes.

Cambridge / Surrey: Universities are allowed to own their own land and buildings. Tuition fees for higher education are allowed, but there is regulation on the maximal level of the fees. Student enrolment is regulated through contracts specifying the minimum number of students in each discipline.

KTH: Swedish universities are not allowed to own buildings or land, and are not allowed to charge any kind of tuition fees. The maximal number of funded students are regulated by the government.

Internationalization

Only of few decades ago, international education was still the preserve of a small elite of potential superstars. But the latter years have seen a massive increase in education generally and today, mobility of students is one of many signs of globalisation. The number of foreign students in the OECD has more doubled over the past 20 years, to over 2 million.[41]

[39] See recommendations on special recognition for Oxford and Cambridge in the influential Lambert review: *Lambert Review of Business-University Collaboration* (2003).
[40] OECD (2003), Survey of University governance among member institutions of the OECD's Institutional Management in Higher Education programme.
[41] OECD (2005), *Education at a glance*.

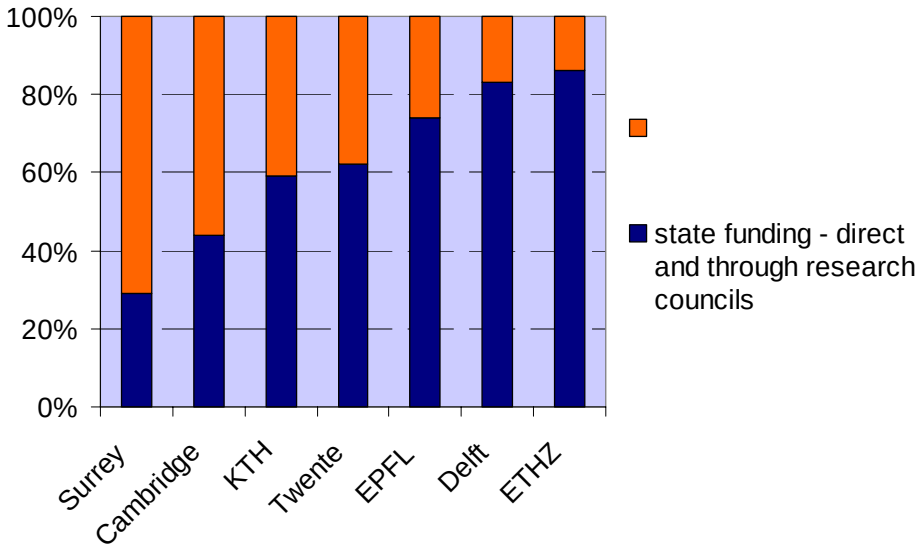
	Students	Doctoral students
Surrey	18 %	34 %
Cambridge	14 %	52 %
Delft	18 %	50 %
ETHZ	11 %	52 %
KTH	7 %	11 %

The fact that KTH distinguishes itself from the compared universities seems troubling. If Universities are allowed to charge fees for foreign students, will KTH be able to use this opportunity? And what does the low share of foreign doctoral students say about KTH's current reputation? What about possibilities to build international networks, or to make foreign recruitments?

Streams of funding

The current funding situations differ in a significant way across European universities. To some extent, this is due to different national systems and regulations. The figure below distinguish between direct funding from the government and funding from research councils on the one hand, and all other streams of income on the other hand.

Being dependent on a single source of income (the state) can be seen risky, especially as further increases of that funding hardly is likely in any European country. A diversified funding base can be seen as both a reason for and an outcome of "entrepreneurial" behaviour on behalf of the University. It can also be noted that levels of state funding allocated on solely scientific basis tend to be higher in the two countries where technical education and research is highly concentrated (CH and NL).



The figure above depicts the level of "traditional" funding at each of the seven compared European Universities. By that, we mean funding distributed directly from the state (for teaching and research) and funding from public research councils - the type of public funding that is distributed exclusively on scientific merits of research funding applications. Not long ago, this type of funding was almost universally prevailing in European universities. Now, however, the general trend of the last decades has been that new forms of funding – tuition fees, foundation grants, public sector funding with special (politically decided) considerations – has increased in importance. And more than that, the traditional funding streams are stagnating in every country studied here. The road to future growth and success for a University inevitably goes through increased reliance on the "new streams".

Direct government funding is in English, Dutch and Swiss contexts allocated after evaluation and/or contracts. In the UK, HEFCE grants for specific purposes are included in this figure. Student fees, endowments and rents (from owned land and buildings) make up a significant part of the non-direct state funding of the two British universities. For KTH, research funding from Vinnova, SFS, etc constitute the main part of the 'other' funding. For the Dutch universities, governmental agencies are included in the figure for state funding.

KTH is already funding its activities through "the new" streams to a rather high degree. To ensure continued success, KTH is reviewing how it can find new funding streams. The question remains: to what extent can a Swedish University attract new funding for research, when such funding so often is accompanied by demands on matching funds – which normally have to be taken from the direct funding stream. And how can KTH find room for strategic behaviour within a funding frame dominated by external actors? Closer studies of how e.g. Surrey addresses such problems would be beneficiary.

Financial assets

Investigating the issue of financial streams one step further, we notice that many universities have incomes from assets. The existence of a financial reserve, either in terms of University development funds or in terms of land and buildings, ensures greater independence and gives the University a greater freedom to make strategic investments.

Surrey: Owns 952 acres of land, all University buildings and a tech-park, 3341 places for students on or nearby campus. Land and buildings have a book value of 1.2 billion SEK.

Cambridge: Property for about 1.7 billion SEK, in balance accounts. The Cambridge foundation has funds of 400 million SEK. The University states that it has a permanent endowment of about 28 billion SEK, providing the University and its colleges with annual incomes on more than 1.2 billion SEK

TU Delft: Owns rich laboratory facilities, including wind tunnels, aircraft simulator, research reactor, water basins, etc. The University is allowed to own its buildings.

Twente: Owns the 150 ha campus area and buildings on the campus, including houses for students and faculty, a Faculty Club and a Tech park. The University has 1 billion SEK in the balance accounts.

ETHZ: Owns its buildings in Zurich and all over Switzerland, valued to 18 billion SEK. The University also owns buildings for staff and (to a lower degree) student housing.

EPFL: Owns its buildings on the campus, including a Faculty Club and a Science park.

KTH: Does not own any buildings and does not have significant financial assets.

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05 Impacts of neck injuries research at Chalmers University of Technology - Summary. *Brief version of VA 2004:07, for brief version in Swedish see VA 2005:04*

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07 En lärande innovationspolitik - samordning och samverkan?

VA 2004:

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06 Effekter av det svenska kompetens-centrumprogrammet 1995-2003 - Sammanfattande rapport. *Brief version in Swedish of VA 2004:03, for brief version in English see VA 2004:05*

07 Effektanalys av nackskadeforskningen vid Chalmers. *For breif versions in Swedish and English see VA 2005:04 and VA 2005:05*

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03 Regional ekonomisk tillväxt i Sverige 1986–2001. En studie av tillväxtens utveckling i Sveriges lokala arbetsmarknader.

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VINNOVA´s mission is to promote sustainable growth
by developing effective innovation systems
and funding problem-oriented research

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