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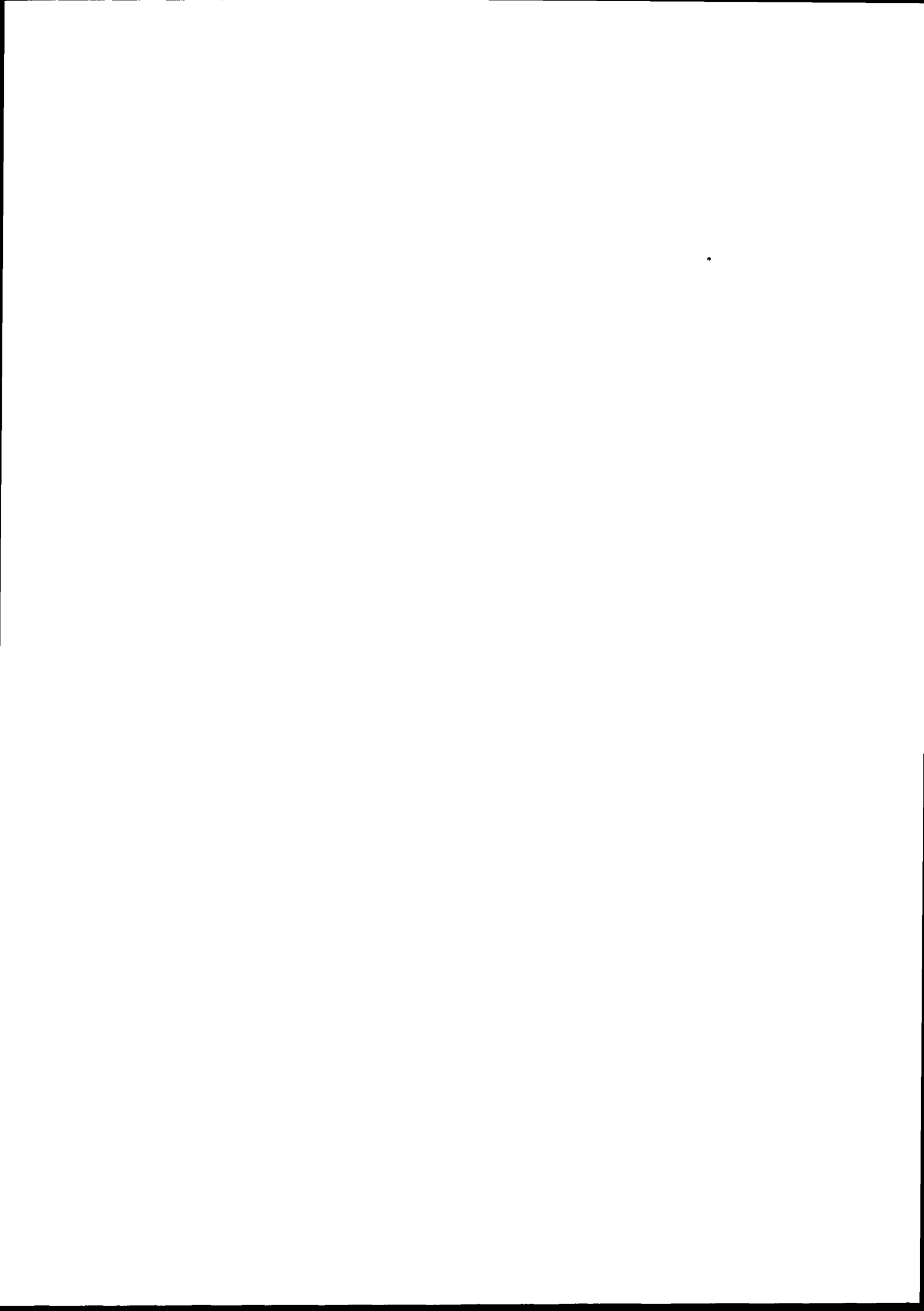
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Med venlig hilsen

Helge Sandén



A Public Good

PhD Education in Denmark

Report from an International Evaluation
Panel

March 2006

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Contents:

Preface	3
Resumé af evalueringspanelets konklusioner og anbefalinger	4
Executive Summary	9
1. Introduction.....	14
2. The PhD in Transition.....	19
3. Perceived Features of PhD training.....	35
4. Graduate Schools – the Norm of International Quality	58
5. Structure and Organisation	67
6. The Implications for Funding.....	81
7. Conclusions and Recommendations	97
Literature	106
Appendices	108

Preface

This report results from the work of an international evaluation panel, commissioned by the Danish Ministry of Science, Technology and Innovation, that I have had the honour of chairing. We commenced our mission in September 2005 and have since then had a period of intense work, including a number of very rewarding visits to Denmark. We have been received with great hospitality and have participated in probing and visionary discussions on a high intellectual level concerning issues of importance for Denmark. We are grateful to all those who shared their precious time, experiences and ideas with us.

We feel very strongly that the time is right for Denmark to take a major step forward by providing an expanded and more internationalised PhD education. PhD degrees represent the utmost of education and scholarship. They also represent the tolerance, rationality and broad understanding that we rightly expect to be associated with science. Good PhD training is carried out in an international environment. PhD programmes in that sense are the vanguard of a world where economies, cultures and nations are continuously bound closer together. We believe that this type of education is also a vanguard for making societies better and more able to live in peace with each other.

For these and other reasons, the PhD programmes should be considered *A public good*. We have included those words in the title of our report because we believe that advanced scientific training is in a period of transition, from something exclusive and rare into something that is much wider and much more needed in all sectors of society. It is in everybody's interest that PhD programmes be of the highest quality and broad enough to attain all their important social functions.

On behalf of the evaluation panel, I would like to acknowledge the support that we have received from all of the individuals and institutions that have provided their assistance. In particular, I would like to thank the institutes that performed the basic work with the data and questionnaires: The Danish Center for Studies in Research and Research Policy (*Dansk Center for Forskningsanalyse, CFA*) at the University of Aarhus, where in particular Svend Ladefoged and Elisabeth Vestergaard have been at our service, and the Swedish Institute for Studies in Education and Research (SISTER) in Stockholm, where Andreas Högberg did statistical analysis and Göran Melin heroically did a little bit of everything, on top of serving as a very able secretary to the panel.

Oslo, February 2006

Sverker Sörlin

Resumé af evalueringspanelets konklusioner og anbefalinger

Panelet har konkluderet, at ph.d.-studiet i almindelighed fungerer godt og giver en tilfredsstillende uddannelse af en høj standard. Vi har kun konstateret ganske få, om nogen, tilfælde af, at ph.d.-uddannelsen gennemføres på et for lavt niveau, men det bør bemærkes, at nogle af ph.d.erne uddannes i videnskabelige miljøer, som i sig selv ikke er særlig stærke. Dette er et resultat af den generelle ordning i Danmark, hvor ethvert universitet kan udbyde uddannelse inden for hvilket som helst fag. Den overgangsproces, som begyndte med ph.d.-reformen i 1993, er nået et stykke vej, men har ikke været vidtrækkende nok. Den må fortsætte og videreudvikles. Den fortsatte overgangsproces vil vare mindst ti år mere, selv om de strukturelle forandringer, panelet anbefaler, sandsynligvis vil have betragtelige virkninger meget før, allerede i løbet af en eller to ph.d.-cykler. Flere af vores anbefalinger har til formål at understøtte koncentration og differentiering, såvel i hele det nationale universitetssystem som på de enkelte universiteter. Vores anbefalinger har til formål at styrke grundlaget for og understøtte en ph.d.-uddannelse, som repræsenterer en høj international standard, og at optimere rekrutteringen af de bedste studerende, også internationalt.

I lyset af den forventede kraftige forøgelse af optaget af ph.d.-studerende i Danmark, er det vigtigt at se nærmere på spørgsmålet om kapacitet. Forholdet mellem antallet af undervisere, opgjort som antallet af professorer og lektorer, og ph.d.-studerende er forskelligt fra institution til institution, men er i gennemsnittet ikke mere end 1 til 1. En normal standard på de bedste amerikanske forskerskoler er 1 til 4, dvs. at én underviser arbejder med fire studerende. Panelet konkluderer, at der generelt er kapacitet til at forøge ph.d.-uddannelserne i det danske universitetssystem.

Målene for ph.d.-uddannelsen er utilstrækkeligt formulerede. Vi anbefaler, at Ministeriet for Videnskab, Teknologi og Udvikling indleder en bred diskussion i universitetsverdenen og blandt interessenter i det omgivende samfund. Vi foreslår, at en sådan diskussion tager udgangspunkt i følgende:

- Ph.d.-uddannelsen er et offentligt gode, der har et bredt alment sigte. Dette er et fundamentalt punkt, som må formuleres omhyggeligt og formidles ud til offentligheden og skatteborgere for at sikre opbakning til stadig udbygning af forskeruddannelserne.

- At uddanne flere ph.d'er af høj kvalitet vil ikke blot styrke Danmarks konkurrencemæssige position i global sammenhæng, men også gøre Danmark til et bedre samfund for dets indbyggere.
- Ph.d.-uddannelsen er et led i internationaliseringen og fordrer øget optag af internationale studerende.
- En høj international standard er den eneste farbare vej for Danmark.
- Udviklingen af ph.d.-uddannelsen er et vigtigt bidrag til at forbedre kvaliteten af forskning og uddannelse i Danmark.

Af disse mål følger, at panelet er skeptisk over for ideen om, at ph.d.-uddannelsen kan strømlines til primært at tjene som drivkraft for økonomisk vækst og konkurrenceevne. Ph.d.-uddannelsen tjener samfundet bedst, når den er en solid og bredspektret uddannelse af højeste kvalitet af forskningstalenter inden for alle videnskabsområder. Det er den slags uddannelse, der tilbydes på de bedste amerikanske forskerskoler. Disse forskerskoler er multifaglige, de hviler på et solidt fundament af kurser og øvelser i teori og metode i forskerskolens eget regi, og de anvender konkurrenceprægede og gennemsigtige optagelsesprocedurer.

Panelet er kritisk over for den måde forskerskoler er organiseret på i Danmark. Nogle forskerskoler i Danmark er innovative, men de er for forskellige, hvad angår indhold og kvalitet. Panelet er af den opfattelse, at:

- Forskerskoler behøver kritisk masse og faglig bredde og derfor solid finansiering.
- Forskerskoler bør organiseres af universiteter, men medfinansieres af andre aktører på et konkurrencepræget grundlag.
- Forskerskoler bør arbejde på et tværfagligt grundlag.

Med dette som udgangspunkt anbefaler panelet, at en stadig større del af de danske ph.d.-uddannelser organiseres i forskerskoler af en anden type end de fleste af dem, der eksisterer i dag. Skabelonen bør hellere være den forskerskolemodel, som er etableret på de førende amerikanske universiteter. Den innovative danske udgave af forskerskoler bør blive det varemærke, som kan bevare og forbedre danske ph.d.-uddannelsers internationale anerkendelse.

Hvad angår pædagogiske metoder og vejledning anbefaler panelet, at

- Kursusdelen bør styrkes og udvides til mindst 9 og højst 12 måneder og bør ideelt set knyttes sammen med det mere omfattende kursusarbejde på kandidatniveau.
- Undervisnings- og formidlingsarbejde bør være et integreret kvalitetskrav til ph.d.-uddannelsen og behøver ikke blive specificeret. En ph.d.-studerende bør højst have 3 måneders pligtarbejde som underviser/forskningsassistent eller tilsvarende faglige arbejdsopgaver.
- Der bør lægges vægt på vejledning og indføres uddannelsesprogrammer for vejledere.
- Det bør tillades, at adjunkter og postdoc-kandidater fungerer som projektvejledere og medvejledere.
- Der altid bør være en repræsentant for en udenlandsk forskningsinstitution blandt medlemmerne af ph.d.-evalueringskomiteen. Undtagelser fra denne regel bør kun tillades ved dispensation fra rektor.
- Ph.d.-afhandlingen skal være offentligt tilgængelig (i det mindste forsynet med ISBN-nummer og tilgængelig på større universitetsbiblioteker) mindst tre uger før det offentlige forsvar.
- Kravene til eksterne hovedvejledere fra sektorforskningsinstitutioner, industrien og den offentlige sektor bør præciseres. Under normale omstændigheder bør det ikke være muligt at fungere som hovedvejleder uden at have en ph.d.-grad eller en anden høj akademisk grad af tilsvarende kvalitet.

Selvom panelet er bekymret over tendensen til, at afhandlingerne tillades at indeholde langt færre publicerede artikler og artikler publiceret i mindre ansete tidsskrifter, foreslår vi alligevel ikke-centraliserede normer: sådanne vil let kunne blive for rigide og virke mod sin hensigt. Udviklingen af lokale kvalitetsnormer bør imidlertid fremmes.

Vi vil gerne opfordre til en bredere definition af mobilitet, som inkluderer optagelse af udenlandske studerende i meget større udstrækning end hidtil. Mobilitet bør forstås som aktiv rekruttering af udenlandske ph.d.-studerende, både som studerende på danske ph.d.-uddannelser og som gæstestuderende på kortere besøg. Et rimeligt mål bør være, at den internationalt rekrutterede andel af de ph.d.-studerende sættes op til 25 procent. Dette vil forbedre den danske ph.d.-uddannelses kvalitet og være en potentiel indtægtskilde (fra studerende fra lande uden for EU).

Panelet anbefaler på det kraftigste, at optagelsesprocedurene laves om, og at der indføres strenge optagelseskrav med minimumskriterier, som defineres centralt. Vi anbefaler en procedure med lokalt fastsatte optagelsesdatoer (en eller to gange om året) og gennemsigtige optagelseskriterier. Vi anbefaler også, at optagelseskomiteen på forskerskolen eller de relevante institutter skal have to eller flere udenlandske medlemmer, og at optagelseskriterierne offentliggøres.

Både 5+3-modellen og 4+4-modellen bør være en mulighed. 4+4-årsmodellen har den fordel, at den passer godt med forskerskoleidéen: bredt og avanceret kursusarbejde efterfulgt af rigelig tid til det specialiserede ph.d.-projekt. Der bør være fleksibilitet i forholdet mellem kandidatuddannelsen og forskerskolen.

Det er vanskeligt at indsamle præcise beregninger af produktivitet og frafald. Panelet anbefaler, at:

- Universiteterne i fremtiden indsamler flere nøjagtige data angående studietid og barselsorlov under ph.d.-studiet, så situationen kan kontrolleres nøje.
- Store overskridelser af den normerede studietid kan føre til sanktioner i forhold til finansieringen af fremtidige ph.d.-studerende.
- Ministeriet for Videnskab, Teknologi og Udvikling overvejer at finde mere effektive måder at måle de reelle studietider på og udregne frafaldet.
- Frafaldets størrelse bliver overvåget mere omhyggeligt, og at data og informationer indsamles systematisk og studeres af universiteterne for at finde ud af, hvorfor ph.d.-studerende falder fra.

Staten bør have hovedansvaret for finansieringen af ph.d.-uddannelserne, fordi de er et offentligt gode med et bredt alment sigte. Al finansiering af ph.d.-studierne bør være synlig, gennemsigtig, regnskabspligtig og retfærdig. Universiteterne bør vedblive med at være de eneste institutioner, der kan tildele ph.d.-graden.

Vi anbefaler indførelsen af ph.d.-kontrakter for at sikre åbne aftaler mellem universiteter og staten angående de respektive universiteters generelle retningslinjer og ambitioner. Ph.d.-kontrakter giver mulighed for, at stat og regering kan have indflydelse på det forholdsmæssige omfang af ph.d.-uddannelserne på forskellige videnskabsområder.

Vi anbefaler, at tilskyndelse til stadig kvalitetsforbedring sikres gennem tre finansieringskilder:

- a) Kernebevillinger. Denne finansiering, som kommer direkte fra staten til universiteterne, bør fastsættes på grundlag af ph.d.-kontrakterne og tidligere resultater, og der bør følges op på dem regelmæssigt, men med temmelig lange mellemrum for at sikre universiteternes langsigtede planlægning. Dette vil muliggøre omfordeling af universiteterne imellem, men i moderat målestok og over en længere periode. Andelen af den samlede direkte finansiering af ph.d.-studier bør være på 30-50 procent i forhold til de totale nationale ressourcer anvendt til ph.d.-uddannelsen. Vi anbefaler, at den i begyndelsen er på 40 procent (inklusive det nye finansieringsinitiativ).

- b) Konkurrencepræget finansiering. Denne finansieringskilde, som bør udgøre langt størstedelen af den yderligere finansiering, er nødvendig for at opnå en hurtigere omfordeling mellem universiteterne og vil være en motivation til kvalitetsforbedring. Den kan inddeles i forskellige kategorier: stipendier, deriblandt medfinansierede stipendier og et +100-program for udvalgte forskertalenter; projekter, deriblandt stipendier til unge forskeres projekter; programmer; forskerskoler. Den største kategori bør være forskerskoler, som behøver betydelig finansiering af den langsigtede investering i ph.d.-uddannelsen. Vi anbefaler, at denne finansiering fordeles af Forskeruddannelsesudvalget, som bør styrkes og udstyres i overensstemmelse hermed, bl.a. med betydelige ressourcer til administration og ekspertbistand for at kunne følge op på kvalitet og resultater, en kapacitet, som også kan yde støtte til regeringen, når den skal foretage de vurderinger, der er nødvendige i forbindelse med finansieringskilde a). Med denne ordning vil Forskeruddannelsesudvalget uundgåeligt få en mere tydelig og central rolle, der kræver, at udvalget har en egentlig beslutningskompetence. Dette indebærer, at de konstitutionelle relationer mellem Forskeruddannelsesudvalget og Koordinationsudvalget for forskning tages op til fornyet overvejelse.
- c) Finansiering af anvendelsesorienteret ph.d.-forskning. Den tredje finansieringskilde er støtte til statslige og erhvervs-ph.d'er. Dette er en videreudvikling og udvidelse af den eksisterende erhvervs-ph.d.-ordning, hvis andel af den samlede nationale finansiering af ph.d.-uddannelsen bør øges, og som inden for sin finansielle ramme bør udvides til også at omfatte den offentlige sektor.

Hvis man ønsker at skabe et bæredygtigt og velafbalanceret universitetssystem, bør postdoc-uddannelser inkluderes i ph.d.-reformpakken. Vi anbefaler, at i alt ca. 20 procent af pakkens totale omkostninger bevilges til postdoc-kandidater i en periode på 2-6 år efter ph.d.-graden. Et af målene med dette er at sikre karrieremuligheder for forskere i forskningssystemet, et andet er at forsyne dansk industri og danske virksomheder med "innovations-postdoc-kandidater".

Executive Summary

The panel has found that the education of PhD students in general works well and provides adequate training that meets high standards. We have observed only a few instances where the education of PhD students was conducted on a potentially sub-standard level, although it should be noted that PhD students are trained in scientific environments that themselves are not very strong. This seems to result from the general attempt in Denmark to allow for the training of PhD candidates in any university on any subject. The transition process, which started with the PhD reform in 1993, has come a long way, but has not reached far enough. It must continue and it should be stimulated to progress. The time horizon for continued transition should be at least ten years, although the structural changes that the panel recommends are likely to produce considerable effects much earlier, already within one or two PhD cycles. Several of our recommendations are designed to support concentration and differentiation across the entire national university system, as well as within individual universities. Our recommendations are designed to serve and support the kind of graduate training that will meet high international standards, and optimise recruitment of top-notch students, including internationally.

In the face of a major increase in PhD student enrolment in Denmark, it is essential to consider issues of capacity. The faculty/PhD student ratio varies between institutions, but is on the average not more than 1:1. A normal standard in the best American graduate schools is 1:4, i.e., one professor works with four graduate students. The panel concludes that there is, generally speaking, a capacity for expansion of PhD training in the Danish university system.

The goals of the PhD education are insufficiently articulated. We recommend that a broad discussion in academia and among stakeholders should be initiated by the Ministry of Science, Technology and Innovation. We suggest the following tentative dimensions be included in such a discussion:

- PhD education is a public good. This is fundamental, and needs to be carefully articulated and widely disseminated to sustain popular and tax payer support of advanced research training for increasing numbers of candidates.
- More and higher quality PhD graduates put Denmark on the road to not only a globally competitive society, but also a society that is better for the citizens of Denmark.
- PhD training plays a part in internationalisation, including international admissions.
- High international standards are the only viable goal for Denmark.

- Developing the PhD education is an essential part of enhancing the quality of research and education in Denmark.

It follows from these goals that the panel is sceptical to the notion that PhD education could be streamlined to serve primarily as a driver of economic growth or competitiveness. The education of PhD students serves society best when it is a solid, top quality, broad ranging training of research talent in all areas of science and scholarship. This is the kind of training that takes place in the best American graduate schools. These graduate schools are multidisciplinary, they rest on a solid foundation of coursework, and they use competitive and transparent admission procedures.

The panel is critical regarding the structures under which graduate schools have been organised in Denmark. Graduate schools in Denmark are sometimes innovative, but are too varied in kind and quality. The panel is of the opinion that:

- Graduate schools need critical mass and disciplinary breadth and therefore solid funding.
- Graduate schools should be organised by universities, but co-funded by funding agencies on a competitive basis.
- Graduate schools should work on an interdisciplinary basis.

With this in mind, the panel recommends that an increasing proportion of Danish PhD research training should be organised to occur in graduate schools of a different kind than the large majority of those that exist today. The template rather should be the graduate school model established in top-ranking American universities. The innovative Danish variety of the graduate school should become the trademark that can sustain and improve the international recognition of PhD education in Denmark.

As for pedagogical structure and supervision, the panel recommends:

- Coursework should be strengthened, and broadened, to a minimum of 9 and a maximum of 12 months, and, ideally, be linked to the more comprehensive coursework offered on the master's level.
- Teaching and dissemination work should be considered an integrated quality demand of PhD training and need not be itemised. There should be a maximum of 3 months of paid work as teacher/assistant for PhD students.
- Supervision should be emphasised and training programmes introduced.

- Assistant professors (*adjunkter*) and postgraduate fellows should be allowed to act as project supervisors (*projektvejledere*) and assistant supervisors (*mædvejledere*).
- A person from a foreign research institution should always be on the PhD examination committee. Exemption from this rule should only be allowed through special permission from the Rector.
- The PhD thesis must be publicly available (as a minimum assigned an ISBN number and available in major university libraries) at least three weeks before the public examination.
- The requirements for external principal supervisors (*hovedvejledere*) from government research institutes, the industry and the public sector should be clarified. Under normal circumstances, it should not be possible to act as principal supervisor (*hovedvejledere*) without a PhD or another advanced academic degree of similar standing.

While the panel is concerned with the tendency regarding the thesis that allows for fewer published articles and in less prestigious journals, we still do not argue for any centralised norms; they would easily become overly rigid and counterproductive. However, the development of local quality norms should be encouraged. Further, we suggest that the present recommendation, that is, that there should be international representation on examination committees, should be made into a requirement in the PhD Order. Exceptions should be decided on the level of the Rector.

We would like to encourage a wider definition of mobility to include admission of foreign students to a much larger extent than is current practice. Mobility should be interpreted to mean an active recruiting of foreign PhD students, both for admissions to Danish PhD programmes and for shorter visits. This is a quality driver of the Danish PhD degree and a potential source of income (from extra-EU students).

The panel recommends strongly that admission procedures be changed and that strict norms for admission be introduced, with some minimum criteria defined centrally. We recommend a procedure with locally fixed admission dates (once or twice annually) and transparent evaluation criteria. We also recommend that the admission panel on the graduate school or faculty level should be required to contain two or more foreign members and that the criteria of the committee be made public.

Both the 5+3 and 4+4 model of organising PhD programmes should be possible. The 4+4 year model has the advantage of matching the graduate school concept: broad and advanced coursework followed by plenty of time for a specialised PhD project. There should be flexibility in the relation between master's programmes and graduate schools.

It is difficult to get certified measures of productivity and dropout. The panel recommends:

- That universities collect more detailed data concerning study time and parental leave during the course of PhD studies in the future so that the situation can be monitored properly.
- That greatly exceeding the recommended length of study could lead to sanctions in the financing of future PhD students.
- That the Ministry considers better ways of measuring real study times, including information on the dropouts.
- That dropout figures be more carefully monitored and data and information be systematically collected and studied by universities as to why PhD students drop out.

The state holds main responsibility for PhD funding, because PhD training is a public good. All PhD funding must be visible, transparent, accountable and fair. The universities should remain the sole degree granting institutions.

We recommend the introduction of PhD contracts to secure open agreements between universities and the Ministry on the general direction and ambition of the respective universities. PhD contracts allow the possibility for state and government to influence the proportion of PhD programmes in different areas of science.

We recommend that incentives for continued quality enhancement be secured through three main funding streams:

- a) Faculty endowments, or core grants. These should be determined on the basis of the PhD contracts, and on past performance, and should be followed up regularly but with fairly long intervals to secure long-term planning in universities. This will allow for reallocation between universities, but on a modest scale and over the long term. The share of faculty endowments or core grants of total PhD programme funding should be between 30 to 50%, and we recommend it to start at 40%.
- b) Competitive funding. This funding stream, which should represent by far the largest proportion of additional funding, is necessary in order to achieve faster reallocation between universities and provide a quality enhancing incentive. It could include the following categories: stipends, including co-funded stipends and a “+100 programme” for selected highly talented PhD candidates; projects, including stipends for young researchers’ projects; programmes; and graduate schools. The single largest category should be graduate schools, which need substantial funding for long term investment in PhD training. We

recommend that these funds in their absolute majority be distributed by the Danish Research Training Committee (*Forskeruddannelsesudvalget, FUU*), which should be reinforced and equipped accordingly, including substantial administrative and expert capabilities for the follow up on quality and performance, a capacity which could also serve as a support mechanism for the government in the assessments necessary for funding stream a). With this arrangement FUU will necessarily take a distinct and central role and must be able to take decisions with authority, which implies that the constitutional relations between the Danish Research Coordination Committee (*Koordinationsudvalget for forskning, KUF*) and FUU need to be re-examined.

- c) Funding for applied PhD research. The third funding stream is to support public sector and industrial PhD candidates. This is a development and expansion of the existing Industrial PhD programme (*ErbvervsPhD-ordningen*), which should increase its share of national total PhD funding and should be expanded to include the public sector.

To shape a sustainable and well-balanced university system, a programme for postgraduate training should be included in the projected increase of funds for research training. We recommend that, all in all, about 20% of the increase over the coming years be allocated to postgraduate fellowships, for a period of two to six years after the PhD degree is conferred. One aim is to secure career opportunities for academics, another aim is to provide Danish industry and companies with “innovation postdocs”.

1. Introduction

PhD programmes in Denmark are expected to experience rather dramatic changes in the near future. The Danish Parliament recently decided to increase its funding of PhD programmes for 2005 and 2006 and the government declared its intention to increase the number of PhD students substantially. An increase of 50% above the 2005 level, during the course of a handful years, has been indicated.¹ It seems natural that such an increase in the number of PhD students should be followed by an overall revision of the financial and structural conditions of PhD programmes.

This revision is not meant to be a threat in any way. On the contrary, there is a need for such changes, and there is a general need in the Danish society for a workforce that is highly educated and with scientific skills and competencies. There is also a need for people with research experience.

In 1993, the education of Danish graduate students was transformed into what can simply be called a modern PhD education. This transformation was thoroughly evaluated by an international evaluation panel in 2000, which presented its findings and conclusions in a report entitled *A Good Start*. At that time, it was possible to evaluate how the new PhD programmes were functioning and the extent to which they were meeting the current needs and requests from the Danish society, both in academic and industrial sectors. It was perhaps more difficult, at that early stage, to evaluate the effects of the new PhD educational structure and elaborate on future needs and developments. Furthermore, essentially nothing could be reported regarding the graduate schools, of which only a few had been started at that time, but since then have grown in numbers, so that they now include more than half of all Danish PhD students. In many academic areas, the graduate schools, in their quite peculiar Danish versions, are the dominating form of PhD education.

Graduate education in Denmark is affected by international changes, be they on a European level or of a global kind. Thus, if we want to create PhD programmes that are internationally competitive, we need to look outside the Danish borders. And internationally competitive is what they should be; there is no question about the present position of Denmark as one of the leading

¹ For example, the Terms of Reference for the present panel (see Appendix 1) states: "in light of the Danish Parliament's decision to increase the number of PhD students by 50% yearly from 2005, the reason for carrying out a new evaluation of PhD programmes in 2005 is evident". Despite the fact that no binding commitment can be made by the Parliament to any given level of funding by a future Parliament, the panel has chosen to follow its Terms of Reference and take as a given, for our evaluation, that this expansion is going to occur.

nations in the world, both scientifically and scholarly. Any other goal for the Danish PhD education would be misguided. Recognition of the high scientific ambitions and precise demands from the Danish society in general has guided us in our evaluation work and has resulted in a set of recommendations that we believe are necessary for achieving these ambitious goals.

How we conducted the evaluation

The experts participating in the current panel met four times in Denmark and once in Stockholm, Sweden. The evaluation panel attempted to act as independently as possible. The following principles guided the panel members in their work:

- Independence. It has been crucial that the panel keep its distance from the Ministry of Science, Technology and Innovation. Although the panel has relied – almost by necessity – on the Ministry for many kinds of documentation, statistical data, earlier reports and also the planning of site visits, Ministry staff have not participated in interviews or meetings, nor taken part in discussions or panel deliberations.
- Pluralism. We have attempted to hear many voices through the evaluation process. In practise, this meant that we contacted representatives from a range of organisations, who were able to give their perspectives on graduate education. The panel members also visited six Danish universities, including the largest ones. The site visits were carefully prepared, with pre-circulated interview questions from the panel and a range of presentations and printed documentation available.
- Strategic evaluation. In full congruence with our remit, we consider the future to be more important than the past. That is to say, although we have drawn our empirical evidence and data from analyses and evaluation of the recent past, we have reflected a great deal and used our creative energy to incorporate the information and insights looking to the future. We have made a serious attempt to suggest quite substantial changes to graduate education that will allow Danish scientific discoveries to remain at the forefront and ensure that Danish PhD programmes meet the highest international standards.

The panel conducted its evaluation and made recommendations using data that consist of three main components: 1) oral or written information from site-visits at universities, graduate schools and faculties, and from interviews with representatives from a range of organisations; 2) a self-evaluation (questionnaire) that was administered to all faculties at Danish universities; and 3) a survey (questionnaire) that was sent to two annual cohorts of Danish PhD students. The Ministry in addition has provided the panel with essentially any figures and facts that the panel has required.

The questionnaires, site-visit plans and interview structures are presented in the Appendices at the end of this report.

Site-visits and interviews

The panel visited eight graduate schools at the universities in Copenhagen, Aarhus, and Aalborg, it also visited the University of Southern Denmark in Odense, the Technical University of Denmark, the Royal Veterinary and Agricultural University, and the Aarhus School of Business. Interviews were conducted in Copenhagen with representatives from student organisations, trade unions and private industry, as well as with policy makers and university leaders.

Self-evaluations

A questionnaire composed of ten broad, comprehensive questions was sent to the twelve Danish universities that have PhD programmes. The self-evaluations were conducted at the faculty level, e.g., at the University of Copenhagen there are self-evaluations from the Faculty of Social Sciences, the Faculty of Humanities etc. The same procedure was used for the universities in Aarhus, Aalborg etc. The completed self-evaluations contain vast amounts of information; they are often some 20-30 pages long. We explored the material both university-wise and discipline-wise, i.e., made comparisons between, for instance, the natural sciences from all universities that have a faculty of natural science, and the same for medicine and so forth.

Survey of PhD Students

A relatively comprehensive questionnaire was sent to two annual cohorts of Danish PhD students. The questions targeted a range of issues related to their course of study, such as supervision, coursework, thesis writing, international experience and future career prospects. Their social experiences during their PhD training were also covered. All PhD students registered at Danish universities during 1998 and 2002 were selected as members of target groups for the survey. These particular target groups were chosen because we wanted to include two sets of PhD students, one group that included students towards the end of their studies or recently finished, and the other group included members who had progressed a bit further and who presumably had a few years of working experience after their PhD education was completed. Thus, questions regarding conditions during the course of their PhD studies as well as questions regarding job opportunities and their employment experiences immediately after completing their degrees could be investigated.

The questionnaire was sent via regular mail. The questions could also be answered through a web-based form. The two cohorts consisted in total of 1,728 participants; 624 (52%) belonged to the 1998 cohort, 578 (48%) belonged to the 2002 cohort. The response rate was 70%, with 1,202

completed forms returned. The Danish Centre for Studies in Research and Research Policy (*Dansk Center for Forskningsanalyse, CFA*), University of Aarhus, was responsible for all practical work regarding the survey, including collection of the completed forms and registration of the answers. Two reminders were sent out. The raw data set was submitted to *The Swedish Institute for Studies in Education and Research, SISTER*, where the data were analysed.

The report – a guide for the reader

Throughout the report, circumstances and a variety of findings are noted and commented upon. However, the majority of our remarks and conclusions are presented in the final chapter. The report, therefore, tries to tell a story, the story of Danish PhD education today, and possibly tomorrow as well.

Chapter 2 presents the broader context in which PhD education takes place. An important goal here is to articulate the meaning of providing state-financed PhD programmes, and the demands and requests society in turn places on the educational system and on the individuals who graduate from it, i.e., the idea of PhD education as a public good. That it is a public good in Denmark relies on its ability to become ever more international. Danish higher education occurs in an international context and is heavily dependent on international trends and changing preconditions on a European and global scale. Hence, it is wise to try to understand how the winds blow and which circumstances will affect the Danish educational system in the near future.

Chapter 3 makes a quick jump from the broad picture and international context presented in *Chapter 2* to the workshop floor of Danish PhD education. Results from the surveys of PhD students are presented, with emphasis on the following components: expectations, supervision, coursework, international experiences, finances and overall satisfaction. Features and characteristics of Danish PhD programmes are presented in the many tables and figures. In addition, more results from this survey are presented in the Appendices.

The Danish variation on American and British graduate schools (*forskerskole*) deserves an in-depth comment of its own. *Chapter 4* deals solely with this topic, and outlines the issue in some detail. Graduate schools (*forskerskoler*), as they are structured in Denmark, are regarded as providing innovative contributions to the international development of graduate education. They have many advantages, but some less functional aspects as well. At this point in the report and evaluation, we start to make recommendations when appropriate.

In *Chapter 5*, the structure and organisation of PhD educational programmes are highlighted. Several observations are made and the circumstances and particularities are discussed and commented upon. Admission, legal and institutional frameworks, mobility, the dissertation, productivity, dropouts and funding schemes are addressed in this chapter. Again, recommendations are also presented.

Chapter 6 examines in detail the financial circumstances of PhD funding. The present order of funding is not functional with respect to future needs and expectations concerning PhD programmes, be they of a scientific character or a societal one. The problems are outlined and new funding principles are proposed.

Chapter 7 provides conclusions and a summary of the issues, including an overview of the primary recommendations. It is quite possible to go directly to this chapter for individuals who are more interested in the final outcome of the evaluation than its details.

2. The PhD in Transition

The PhD degree, or the Doctor of Philosophy, is the highest academic degree.² Since the Middle Ages, the doctorate has developed as a concept, including its content, at universities. Currently, it is based on as many as twenty years of study in school, including the obtainment of lower degrees, and it typically is earned by students who have shown unusual abilities of learning and scholarship.

Historically, the doctorate has always been an exclusive degree, principally used as a qualification for academic posts, for which it has typically (although not universally; the universities of Cambridge and Oxford were exceptions well into the 20th century) been regarded a necessity. The PhD education, and even more so the extended Habilitation or Dr. philos./Dr. scient. etc. degree, has been discipline-oriented, focusing on the transmission of tacit skills from professor to student, and only to a limited degree oriented towards broader societal problems and issues. Enrolment figures regarding PhD students, thus, have been relatively low, especially compared to the enrolment of large numbers of undergraduate students in the 20th century, and success rates often have been quite low. This has been true for many countries, not least Denmark, where traditional training of doctoral candidates (for a variety of degrees, see footnote 1), before the general PhD reform of 1993, was very demanding, time consuming and at the same time both informal, traditional and exclusive.

World wide growth of PhDs

These characteristics of PhD educational programmes are changing worldwide. The PhD remains the highest degree, but it is no longer as exclusive as it used to be. In the past few decades, there has been rapid growth in the number of PhD programmes. The pattern in many European countries suggests that the annual number of new PhD degrees granted has doubled or trebled since the 1980s, increasingly more women are earning degrees, and the share of foreign students

² In Denmark, there are other doctorates, sometimes called the "classical" degree (*Klassiske doktorgrad*), such as the Dr. theol., Dr. jur., Dr. phil., DR. techn., Dr. oecon., Dr. merc., etcetera, which are considerably more demanding and typically require several more years of study and research. There are more than twenty such degrees, the oldest dating back from the foundation of the University of Copenhagen in 1479, but the large majority dating from the 20th century and several from as late as the 1970's. In this report, we will use the term PhD in accordance with the university legislation in Denmark and disregard the classical degrees, unless otherwise stated. The classical doctorate is retained but is taken by a dwindling number of individuals, 65 in 2002; *Fra Forskerakademiet til FUR 1986-2003*, Forskningsstyrelsen (2003), p. 54.

studying abroad is increasing steadily, with the UK as the leader (almost half of its full-time PhD students are non-UK citizens).³

In the United States, the growth has been somewhat less impressive – a doubling of the number of PhDs awarded between 1965 and 2000, with stagnation in the 1990s, which would have been a falling trend if women and foreign PhD students had not been compensating for the major downturn in PhDs awarded to American men. As of the early 21st century, the number of American men and women earning doctorates in the US are almost equal and the proportion of foreign students earning PhDs has been growing substantially.⁴ In the US, nevertheless, the number of PhDs awarded was already high after the tremendous growth that started in the 1920s and continued throughout the 20th century.

In parts of Asia and Latin America, the growth rate has been higher than anywhere else, thanks to the recent establishment of universities combined with strong economies and ambitious science and technology policies. Per capita, however, the number of PhDs in these countries is still very low, but is expected to continue to increase.

In the Nordic countries, there has also been considerable growth, with a 100 to 200% increase in the number of new PhD degrees granted per year in the last quarter century (Figure 1). Sweden has had the highest growth in absolute terms, but all the Nordic countries have demonstrated the same general pattern, with high and sustained rates of growth in medicine and technology, and slower growth in the sciences and, in particular, the humanities and the social sciences. In relative terms, the conditions in Denmark in the 1990s might represent a world record, with more than a 500% increase in the number of PhD degrees awarded between 1987 (167) and 1997 (871).⁵ On the other hand, the Danish expansion showed a remarkable stagnation in the late 1990s and has only increased marginally in the last decade (Figure 1). The signalled increase in PhD programme funding should be seen against this background. It can also be seen against the background of the present funding situation, where the financial responsibility for PhD training is left largely to the universities and their core grant sources, and where the system provides no tangible incentives for the universities to increase the number of PhD degrees awarded. We shall return to this theme below.

³ Data from academic year 2001-02. *Doctoral Studies and Qualifications in Europe and the United States: Status and Prospects*, ed. Jan Sadlak (Bucharest: UNESCO, 2004), ch. 14. However, since part-time PhD students are almost all domicile, the share of total enrolment is closer to 25%.

⁴ *Doctoral Studies and Qualifications in Europe and the United States: Status and Prospects*, ed. Jan Sadlak (Bucharest: UNESCO, 2004), p. 273.

⁵ Although, of course, it should be noted that the classical *Doktorgrad* requires a much longer gestation. Source: *Fra Forskerakadmiens til FUR 1986-2003* (Forskningsstyrelsen, November 2003), p. 51.

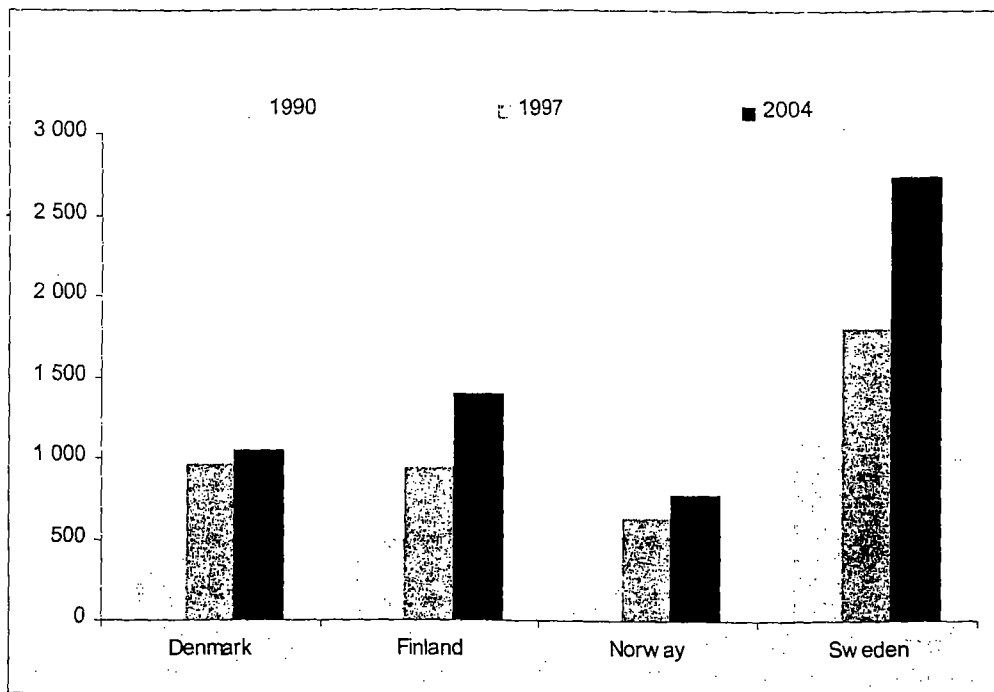


Figure 1. Number of PhD degrees granted (including the two year licentiate degrees in Sweden) in the Nordic countries (excluding Iceland) in 1990, 1997 and 2004.

Overall, and certainly in the Nordic countries, the state (in federal states this is often the regional state) is the primary organising force and funding agency of PhD programmes. The recent growth in PhD programmes has also been principally instigated and made possible by the state, which is not to say that other forms of funding do not exist – foundations, research councils and private sponsorship often play significant roles in funding. In some countries, notably the US, PhD education is as much a market phenomenon as is any form of higher education, with considerable enrolment fees. The salaried PhD student, with access to the full rights of a welfare state, is a rare creature, who in principal only exists in a few northern European countries, one of them is Denmark. Whether the model of paying salaries to PhD students will be the norm, or whether it is just an unusually expensive way of guaranteeing a supply of super competent labourers to key industries and to the state – and thus rather a sign of the low local market value of the PhD – remains to be seen.

The high level of state involvement greatly clarifies the driving forces behind modern PhD training. The PhD degree is no longer seen as primarily, let alone exclusively, a representation of academic heritage and a breeding ground for the next generation of university teachers and scholars. PhD students are now trained also to sustain a growing demand for advanced research competencies in

society at large. People with PhDs are increasingly employed in private R&D laboratories and specialised research institutes and government laboratories, which indeed they have been throughout the 20th century. Increasingly, individuals with PhDs are also employed in firms and public agencies as leaders and directors of advanced activities of many kinds.

The trend of increasing numbers of conferred PhDs is likely to continue. In a recent UNESCO report on thirteen countries (twelve European countries and the United States), it was pointed out that there is a perceived need on the policy making level for a greater number of researchers in Europe. The shortage of qualified scientific manpower is massive and varies, reportedly, between 600,000 and 800,000 scientists across the European Union. In documents from the European Commission this shortage of scientists is repeatedly stressed, with reference to the Lisbon Strategy on shaping a competitive Europe. Among the most eloquent of those voicing this concern has been Philippe Busquin, former European Commissioner in charge of research, who repeatedly argued that “Europe more than ever needs research”; it is a matter of “economic survival” due to the fact that “half of [the economic] growth is being obtained through innovations”.⁶

New demands on PhD graduates

An essential aspect of the expansion and the changing characteristics of PhD training is the way science and technology are getting ever more deeply involved in the core of the innovation processes of society, which in turn are related to economic growth and performance. The skills and capacities of people with PhDs are needed more now than in the past. A recent report on the American PhD places particular emphasis on this and presents a broad range of new initiatives that have been taken by several universities to enhance the teaching and communication skills of PhD graduates, to facilitate their career development and their transfer to the professoriate, and to open up new ways for external interests to enter into a dialogue with universities on the directions and aims of PhD training.⁷ Analyses in many European countries give essentially the same message.

This is why governments, in alliance with, or at least with the understanding of, important social actors, notably private industry, have intervened into this traditionally esoteric and marginal academic domain and requested changes. This development – which appeared spontaneously, and earlier, through market forces and the heavy militarisation of research in the immediate post-WWII decades in the US – has been met with support by those – sometimes quite different groups – that have asked for other and deeper changes regarding a so-called “knowledge society”. Advanced

⁶ *Doctoral Studies and Qualifications in Europe and the United States: Status and Prospects*, ed. Jan Sadlak (Bucharest: UNESCO, 2004), p. 7.

⁷ *The Responsive Ph.D.: Innovations in U.S. Doctoral Education*, The Woodrow Wilson National Fellowship Foundation, September 2005.

competencies in research and development are usually seen as useful for technology transfer, for the dissemination of knowledge to developing countries, and for addressing major and common problems of health, security, equity and the environment.

In general, the intervention in this academic realm has been met with sympathy from academia itself. It has meant, by and large, more funds for research and training and solid proof of the status and importance of the work done in universities. However, to the extent that the massive increase in graduate training has also been received with some reticence, it has often come from the academic community. Universities have claimed that growing numbers of students will produce lower quality of training and less motivated and less gifted students, often funded on fairly generous stipends and (in some Nordic countries) salaries. Universities have also noted that there is an in-built tension, particularly over the long term, between the qualities of the PhD programme as a scientific and scholarly activity and as a programme geared towards maximum utility for businesses or public agencies. Moreover, they almost universally claim that the expansion of PhD programmes is not fully funded to cover all overhead costs and the enhanced capacity of fundamental research that are needed to sustain and maintain in sound balance a growing research training institution.

In a certain sense, this reaction of universities is both understandable and foreseeable, and it should not be overstated. It is countered, as already mentioned, by the benefits to universities with the growth in PhD enrolments, and their opportunities to contribute to society, which they often willingly do. However, this tension nonetheless has been important for the present evaluation and for assessing the current and future demands on PhD training in Denmark. It is obvious that one could take different positions on how, and according to which principles and perspectives, the future goals and organisation of PhD education should be formulated.

The position of this panel is that it is essential that academic and societal demands be balanced. After collecting impressions and evidence across the Danish systems for education, research and innovation, and with as broad ranging an outlook on current Danish society as we have been able to assemble, we are convinced that what is needed is research training that remains on the highest possible academic level and that the additional skills and demands that are needed should be provided in ways that do not harm or dilute these properties of PhD education. In fact, maintaining a very high and solid scientific quality of the PhD degree is the best, if not the only, way to secure the kind of enhanced, innovative capacity and improved economic performance that are also essential components of the larger political picture of research and research training. This also means that expansion of PhD programmes should not, in the panel's view, take place only in those scientific fields that are most easily conceived as drivers of economic growth - medicine,

technology, science – but in the humanities and the social sciences as well. Indeed, the broad balance between fields in Denmark should be considered valuable, as it has consistently proven compatible with a very high overall performance of the Danish university system.

It seems to the panel that Denmark now faces a unique window of opportunity. In an unprecedented move, the Danish Parliament (*Folketinget*) has declared its ambition to increase funds for PhD education by some fifty% in the coming several years. Used wisely, these funds have the potential to set not only Danish PhD education but its research and innovation systems on a path to progress and prosperity. This report is about how that could be achieved.

A good start? The report from 2000, six years later

The present evaluation follows on a previous evaluation conducted in 1999-2000 by an international panel chaired by Peder Olesen Larsen. It was a solid and broad ranging study conducted six years after the 1993 reform. It came in a sense too early to be able to take any final position on the success of the reform. However, it was possible for the Olesen Larsen panel to make an interim judgment, captured in the title of the report, *A Good Start: Evaluating Research Training in Denmark*.

The assessment report, published in 2000, contained a number of recommendations, of which many have been implemented by changes in the Ministerial Order and by changes in the universities. The report contains a large number of recommendations, but at a more general level, the points below stand out as important.

1. There were no clear statements of goals, either at the superior political and administrative level, or at the level of individual universities. It was strongly recommended that precise goals should be formulated. The goals should include the number of enrolled PhD students, based on capacity and needs, the mobility of PhD students and the desirability of foreign students.
2. Danish research training must necessarily meet international standards and be internationally competitive. The PhD programmes should be comparable with the best in the world. Therefore, Danish research training should be integrated in an international research environment.
3. Danish research training should be conducted through well thought out, carefully planned and cohesive programmes and, preferably, in large and powerful environments. This was not the case in 1999. A number of research environments were identified as small and weak.

4. The "age problem" must be dealt with. Many Danish students started their university studies at a comparatively older age and studied for an unacceptably long period. These problems were carried over to the PhD studies and PhD students were relatively old when they finished their research training.

5. The universities have and must have responsibility for research training. In the report, it is stressed that not all universities or faculties necessarily can meet the demand for an active research environment and secure high quality. The report discusses whether all universities and faculties should provide research training.

6. The need for an increase in the number of PhD trained researchers is pointed out very clearly. The report argues that more resources should be transferred to the research training system.

7. It is recommended that research training should be a more integrated part of the development of the society as a whole through constant improvement in the research training system.

The overall assessment by the present panel is that a number of the Olesen Larsen panel's recommendations have been acted upon, but that there is still potential for significant improvement. Perhaps the most fundamental change hitherto made is the one that concerns the number of PhD trained researchers, which is likely to increase substantially in coming years.

This is not to say that there are not some problematic issues that remain, for example a relatively older age at completion of PhD studies, particularly in the social sciences and humanities, and a lack of clearly formulated national and local goals and targets. Even in 2006, many weak and low performing research environments remain with research training programmes of dubious quality. The Olesen Larsen panel recommended that there should be a way for the state to limit, through central decision making, the freedom of universities to provide PhD programmes in any area of their choice. This recommendation was not acted upon, however, since it violates the principal autonomy of the university.

It seems obvious to the present panel that although the principle of local autonomy within the institution is commendable, the provision that PhD level research training should only be performed in suitable research environments or be performed in cooperation with external institutions (according to *Bekendtgørelse* §2) is not always applied. Quite simply, there is a trade off between the local autonomy that constantly tempts institutions to provide PhD programmes in ever more far ranging fields and the quality of the programmes, which typically demands a substantial research environment with a high density of researchers. The power of the forces that

work to increase the disciplinary range of PhD level research training in any local university should not be underestimated. Counter-forces are necessary to control this "PhD drift".

This issue remains critical if Danish PhD training is to meet international standards, and the panel has been considering measures to strengthen central quality assurance while still maintaining full respect for the local freedom that is set down in the University Law (*Universitetsloven*) of 2003. While previous regulation (e.g., *Bekendtgørelse* §§ 8, 9, 30) has provided adequate instruments and obligations to individual universities and faculties to monitor and maintain the quality of individual's PhD research – compulsory individual study plans checked twice a year, the naming of external advisors, the naming of an independent PhD committee, the requirement of a pre-evaluation – it seems that the instruments and measures to follow up on the quality of the degree granting institution are not fully adequate. It has been an important, and difficult, goal for the panel to find ways to secure the balance between *local academic freedom* and *system quality* to assure the best possible PhD education across the research system as a whole.

It should also be noted, however, that some of the changes recommended by the Olesen Larsen panel were met with considerable criticism among the universities. The report was interpreted by some to imply a radical departure from traditional PhD training, with its focus on academic goals and principles, and a far-reaching commercialisation of university research. While this was clearly an exaggeration, the debate on *A Good Start* nevertheless reflects the kind of tensions that any government or public agency is likely to encounter when it tries to intervene, even with the most noble of aims, into core areas of university competence.

National goals – essential for improvement of PhD research training

As early as 2000, the Olesen Larsen panel stressed the importance of clear goals for the PhD education. It was an expected observation. What often happens in transition periods is that the challenges posed by reality come first, the full understanding of what is going on only surfaces later. In the pre-1993 system, when research training was chiefly an internal academic affair, there was little need for the articulation of goals. This need has increased with the growing size of education enrolment figures, degrees and the multi-faceted demands on educational programmes that come from outside the university. Goals need to be articulated and stipulated both in order to keep the educating institutions focused and, perhaps as important, to protect these institutions from the excessive and temporary demands that inevitably arise and may distract them from their central tasks.

There is indeed a formulation in the University Act of a general goal for Denmark's PhD education. However, it is very generally formulated and we would like to take this opportunity to articulate some principal guidelines that we believe should be widely discussed. There is a need for something that we might call a *National PhD Agenda*. The five goals elaborated below by no means are an attempt to provide such an agenda, but perhaps they could be seen as suggestive of the kind of issues such an agenda should contain. Nevertheless, the goals listed have been part of the background thinking of the present evaluation panel. They are:

- a) PhD education is a public good.
- b) The core mission of PhD training is to maintain and enhance the quality of the research and innovation system in Denmark.
- c) High international standard of the PhD education is the only viable norm for Denmark.
- d) More and high quality PhD's puts Denmark on the road to not only a globally competitive society but a society that is better for the citizens of Denmark.
- e) PhD training is part of internationalization, including international admissions.

a) PhD education as a public good

PhD education represents the highest formalised degree that is granted in higher education. In the past, the training of PhDs was largely an academic auto-reproduction, training by the present professors of their future colleagues. With rising demands on PhDs to serve broader societal needs, it is increasingly evident that PhD training is a public good. Proficiency in research and substantive knowledge is generally thought to be of service to the society at large, whether it is funded by private sources or publicly. Higher education and especially PhD training, creates candidates with skills that serve society at all levels. PhD education not only can aim to service sectorial needs, but in Denmark should be a resource that supports national development under ever tougher conditions of competition and globalisation. PhD education can be of importance in specific innovation processes in industrial sectors, but it is equally important that PhD graduates' acquired skills make an inroad into all societal arenas. The point of the PhD education is that it should play a role in managing the broad spectre of social needs that Denmark faces. PhD education should create engaged, skilled and proficient professionals who contribute to economic innovation processes, public health, culture, education and society at large.

b) The core mission of PhD training is to maintain and enhance the quality of the research and innovation system in Denmark

This may seem an unexpected goal given the transition discussed above and the growing demands for market-oriented PhD graduates. Still, it is crucial. We must remember that while growing numbers of PhD degree holders assume positions in society at large, they also comprise the backbone of future generations of scientists and scholars, not only in universities but in all laboratories and research environments, be they private or public. The research carried out in these institutions will only be meaningful, let alone successful, over the long term if the people working in them have solid training themselves and experience with top-notch research. Research trained people do not just set the standards of their institutions, they are also those who are recruiting and supervising the next generation of scientists and scholars. An erosion of standards in PhD education, therefore, is likely to threaten the quality of the entire research system. Conversely, improvements in PhD education produce exponentially enhanced capabilities of that system. Needless to say, it is also crucial from the standpoint of the individual who will become more competitive in an international labour market for PhDs.

This is precisely why the issue of quality is not only important, but why it must be the core mission of PhD training. This statement may seem simple and seemingly self evident. But, as we shall see, it has considerable implications. The issue of research quality is especially important in Denmark, where research performance has improved radically over the last decade according to bibliometric indicators. Denmark, along with the other Nordic countries, ranks highly on almost every research performance indicator, and has even reached the number one position in the world on what is sometimes seen as the most substantial indicator, the Relative Citation Impact (RCI). In the last few years, Denmark has surpassed the US, which has been the long time leader. To maintain this standing requires a tremendous focus on quality, particularly since there is a risk that increased proportions of PhD research, resulting in many publications in less-cited journals, will push the RCI rate downwards.

c) High international standards for the PhD education are the only viable norm for Denmark

Quality of research is decided on in the international arena. There is no Swedish, German or American knowledge, nor is there in the world of science any Danish reserve where theories and results are exempt from international scrutiny or competition. This is also true for research training. The best research training institutions in the world are almost totally permeated by international

presence. They are of course located within the boundaries of a country, chiefly in the US and the UK, but their faculty, enrolment and general outlook are international. At Cambridge University – to give one significant example – there are 8,000 applicants to their postgraduate programmes annually, out of which some 2,000 are accepted, and about as many leave with either an MPhil (master) or a PhD degree; that is twice the total output of PhDs in all Danish Universities together. At the University of California, Berkeley, some 1,000 new PhD graduates go out on the job market every year. The typical pattern is that the new PhDs from these universities go elsewhere for their first postdoctoral position, very often it is required. The leading PhD producing universities in the world provide an enormous surplus, to be harvested by colleges and universities all over the world.

These are exemplars that could not be easily emulated. Still, *graduate schools* of this kind establish the international quality standards with which all the rest are compared. Denmark is no exception. Our recommendations are intended to move the Danish PhD system in the direction of the best research training available.

d) More and higher quality PhDs put Denmark on the road to not only a globally competitive society, but a society that is better for the citizens of Denmark

The PhD graduate is to the knowledge-based globalising economies what the freshly trained engineer or technical entrepreneur was to industrial capitalism in its earlier phases. Innovation systems have undergone dramatic changes in recent decades. Countries that wish to stay competitive with high wages and high ambitions for their welfare states must be innovative and maintain advanced positions in the quest for new technologies and social solutions. That, in turn, demands a density of research trained personnel in many, if not all, main sectors. PhD graduates are the leaders of knowledge development and management. Indirectly, therefore, more and higher quality PhD graduates benefit the citizens of Denmark through the positive effects they will have in the country's adaptation to the globalising knowledge-based economy.

Furthermore, well-trained PhDs can provide intellectual and rational leadership in many areas of society, not just in research positions. They can improve the quality of advanced services and intellectual analytical projects in many areas. They can also provide the stem and marrow of the "creative class" (Florida 2002), which is characteristic of successful cities, communities and nations. From the panel's perspective, the training of PhD graduates is a solid and reasonably safe investment in a fair society with more opportunities for more people, and with increased potential for dealing with crucial societal problems.

e) PhD training plays a part in internationalisation

Denmark is affected by globalisation and internationalisation as much as any other country. Indeed, the government has appointed a high level Globalisation Commission to address related issues. We suggest that PhD training should be considered a spearhead for this process. PhD training is inherently international and entails great potential for furthering internationalisation of academic life, advanced professional life, as well as being an exemplar for other sectors of society. The above-mentioned report on PhD training in American universities cites precisely this – the diversity, especially the ethnic diversity, among PhD students – as one of the key quality indicators of PhD education.

In particular, PhD training could and should be used to increase pluralism in the Danish higher education sector. Large numbers of applicants, preferably from foreign countries, will secure the best possible quality of graduates. If sizeable portions of the graduates stay in Denmark, this will increase diversity among faculty at Danish universities, which in turn is likely to drive quality and reinforce international networks, which will probably make Danish universities stronger and provide more opportunities for Danish researchers. The current number of international admissions to PhD programmes – some twelve percent – should be increased substantially; a foreign student enrolment of around 25% seems a reasonable goal for the coming decade.

The need for a long-term perspective

If these goals are taken seriously, they will have deep ramifications for the PhD training institutions. This would serve as an antidote to quick fixes and easy solutions. Goals like these send a strong message to all parties with interests in PhD degrees: this is hard work over the long term, and it needs solid anchoring in academic research.

To achieve these goals, it is essential that the substantial progress made, since the reform of 1993 and since *A Good Start* was published in 2000, is continued and driven much further. The years ahead provide a window of opportunity. Since 1993, there has been a transition from an informal, discipline-based training under “mandarin” professors to modern, course-oriented graduate schools. This transition has come a long way, but has not reached far enough. It should be pushed forward.

We do not underestimate the changes that are still needed. To change from an individualistic and widely dispersed system to one marked by stronger research environments taking responsibility for a larger proportion of the training is easier said than done; the changes that have occurred since

1993, and since 2000, are proof of that. The collective activities could be designated as cultural changes, involving not just changes in method, organisation, funding and principles. They involve what sociologist Pierre Bourdieu calls *habitus*, the everyday procedures that are taken for granted. Change requires time for adjustment, for groping forward under special local circumstances. The time horizon for continued transition should be at least ten, maybe fifteen years, although the recommendations provided by this panel are designed to make an impact already in the immediate future and will change the PhD training system within one or two PhD cycles.

Change is not an end in itself and the panel has tried to keep the suggested changes few but substantial. All reforms that the panel recommends are designed to serve and support the kind of PhD education that will meet high international standards, and optimise international recruitment of top-notch students.

In due course, we return to what these recommendations are and to the reasons we have found, in current practice, for proposing them. At this point, we will sketch briefly, in a kind of headline fashion, the factors that we perceive as essential for achieving the high international standards that Danish PhD training requires and wishes to achieve.

The first factor is *firm and fair incentives*. The institutions that provide the education must be rewarded for their work when it enhances quality and efficiency. This, we believe, could and should be done. We will propose a number of instruments, both through principles and funding mechanisms.

A second factor is *firm and fair quality enhancement schemes*. PhD training in a state-run system of higher education and research needs constant monitoring and evaluation to make comparisons possible and to stimulate progress. This will provide the foundation for reallocation of resources for PhD training over the long term. Some institution must carry the primary responsibility for this job.

A third factor is *firm and fair organisation*. So far, Danish PhD education has been marked by a remarkable pluralism, sometimes verging on the chaotic. Very tight, small "mandarin" educational environments have co-existed with vaguely organised department-based PhD training, and a mushrooming plethora of "graduate schools", some of which are very large and with national coverage, others hardly distinguishable from a core course programme on the faculty or department level. While variety of form is probably a strength - not all should be measured by the same yardstick - we see a need for an organisational reform. In particular, the most advanced, leading research environments should be reconsidered. The organisational issue is, needless to say, deeply intertwined with the issues of incentives and enhancement, mentioned above.

International outlook: Changing preconditions for academic research and higher education

The Danish PhD education is taking place in an international context where changes in other parts of the world, nearby or far away, influence the national and local preconditions. Policy makers, university staff and students have to take the circumstances in the global scientific arena into account when forming a PhD education policy, establishing a research school or choosing a PhD programme. The context in which research and higher education occurs is always dynamic, and perhaps increasingly so. How should European universities understand their own position in this very complex and partly super-national, partly de-national, partly global, partly European, and yet partly national scientific system? How should smaller universities in small countries view their situations?

During recent years, there has been increased competition within the scientific sector of society. The competition seems to occur on all levels throughout the system: on an individual level, on a group level, on a departmental level and on a university level. The competition is for funding first and foremost, but related to funding is the need for personnel with certain skills, and for students as well. Through recruitment of "good" staff and enough students (or students who can pay tuition fees, where this is applicable), a university can hope to be able to attract funding and secure a position in the top layer. On team and department levels, the focus is different but the race is still on there as well, with the constant search for additional resources.

The hardened competition for funding separates the actors, i.e., the universities, into potential winners and losers. Those that are part of the upward spiral – good reputation, more students, higher tuition fees, better researchers and teachers, stronger scientific performance, and even better reputation – are able to maintain their positions. Already strong centres get even stronger. Alliances and fusions between universities occur in order to strengthen the scientific core and attract research money. Weak universities, or universities that are too small to create a critical mass for research that is good enough to attract stable funding, are at risk of experiencing a steady-state or a downward spiral instead, from which it is very difficult to escape.

This development reveals possibilities as well as threats. If we look at scientific production in quantitative terms – published journal articles – there is evidence of an ongoing equalisation process among the world's countries since at least a couple of decades. Scientifically small nations take shares from the established ones. In the future, "new" scientific nations will establish themselves as strong science producers. In countries like China, India, Mexico, Indonesia, Turkey, Thailand and Brazil, self-confidence regarding economic and technological abilities is already

significant and growing, and this sense is spreading to scientific production. In Japan, this attitude has been prevalent for a long time, in South Korea and Taiwan for a few decades. Alliances and links between good “new” sites and Western universities are established. And non-Western universities are increasingly considered as worthy partners. Only recently (January 2006), an International Alliance of Research Universities (IARU) was formed between ten top-notch universities in Asia (Beijing, Tokyo, Singapore), Europe (including the University of Copenhagen) and the US; the agreement was signed in Singapore. Cultural diversity can be seen as a source of scientific development. Differences and disciplinary border-zones, or border-zones of a cultural kind, can thus be sought and exploited.

Another trend concerns the converging policies of research and higher education on the one side, and innovation on the other. They are increasingly related to each other and often entangled in reality. Possibly, creativity and innovation might be of greater importance to our universities in the future in terms of profiling and attracting funds. For some, it may be a matter of survival. For this reason, it is important for an internationalisation approach to bridge the gap between academic knowledge production and knowledge mediation and innovation.

When there are new players in the scientific arena, it is important for anyone who wants to participate in that arena to connect with them. It is important to have the tools to establish new links, get involved in new networks and initiate new collaborations. Danish scientific milieus will need to link up with foreign scientific milieus even more than is necessary currently, and not only with established Western ones. Initiatives at universities and departments to establish contact and exchange with non-traditional scientific sites in non-Western countries are important as well. This can be done in many ways and through different support schemes or activities. Many PhD programmes and research schools encourage their students to spend a semester or so abroad during their education, in accordance with the recommendations in “PhD bekendtgørelsen”. Besides providing students with invaluable experiences and international contacts, this type of built-in foreign exchange establishes a mentality in which international connections are a natural part of the work, from the beginning of a scientific career. It must be seen as completely natural to establish some international contacts and spend some time as an exchange student, as a postgraduate fellow or as a visiting scholar during a lifelong academic career.

This brief sketch of what is happening in R&D on a global level predicts a slight shift from today’s situation towards a more scattered and diverse university landscape. There are more academic institutions that are active in the scientific arena, and they represent a larger diversity than is apparent in the “Humboldt University model”, which has been prevalent so far and, although

developed, has remained principally unchallenged, certainly as an ideal and to some extent also in reality. It is probably not possible to compete successfully with the traditionally strong universities in the US and UK in terms of scale; the resources they have created during the past decades and the reputation they have established over centuries, in general, are impossible for Danish universities to challenge. But, in a more diverse academic landscape with more actors and greater variation in scope and orientation, there is room for *profiling* and there is a demand for *quality*.

Danish universities have excellent possibilities for developing and strengthening their research base as well as their recruitment base through profiling their research and education, and by benchmarking their quality towards the leading institutions in the world, in any given field of study. That is the possibility of a small nation with highly developed research institutions and with a higher education sector already of world class. No single university can do everything – even the very best, Harvard, MIT, Cambridge, profile and specialise – but any Danish university can develop research and PhD training of the highest international standard in some prioritised area, or several. That is a matter of sound policy management, strategic thinking and constant safeguarding of academic quality.

3. Perceived Features of PhD training

What are the features of the Danish PhD education? Although throughout this report we provide facts and perspectives on the empirical realities, in this chapter in particular we present some of the most important findings from a survey sent to two cohorts of PhD students. The purpose is not only to give voice to the PhD students themselves, however important this may be, but also to provide additional information on how the actual PhD training is working “on the ground”, and how it is perceived. The survey provides many answers to crucial questions regarding circumstances on a somewhat more detailed and practical level than many of the issues that are otherwise discussed and elaborated on in this report: How is supervision perceived in reality? Does the system with study plans work? Why does a young student want to start a PhD education? Are the courses relevant and are they of sufficient quality? What about international exchange? Are the PhD students satisfied with the education they got, after they have finished?

The survey was sent to Danish PhD students and resulted in 1,202 completed responses. The survey contained over 50 questions in total and the results point out many interesting features of the Danish PhD education. The presentation of the data and the comments concerning them are arranged according to the following outline:

- expectations of the PhD education
- supervision
- coursework
- international experiences
- finances and overall satisfaction

To begin with, Tables 1 and 2 show the distribution of the responding PhD students by university, gender and main scientific area. In total, 46% are women and 54% are men, a division that is reasonably standard in OECD countries.

Table 1. PhD students by university and gender, percent. N = 1202, n = 1183.

University	Gender		Total
	Female	Male	
University of Copenhagen	15.7	12.8	28.4
University of Aarhus	9.6	10.3	19.9
University of Southern Denmark	4.3	4.8	9.1
Roskilde University	2.1	1.5	3.6
Aalborg University	2.0	5.7	7.7
The Royal Veterinary and Agricultural University	3.7	3.7	7.4
Technical University of Denmark	3.9	10.6	14.5
Denmark's Pharmaceutical University	1.4	0.8	2.3
Copenhagen Business School	1.3	1.4	2.6
Aarhus Business School	0.8	0.8	1.6
Denmark's Pedagogical University	1.6	0.8	2.4
The IT-University of Copenhagen	0.2	0.3	0.4
<i>Total</i>	46.5	53.5	100

Table 2. PhD students per main scientific area, N = 1202, n = 977.

Main scientific area	Frequency	Percent
Humanities	122	10.1
Social Sciences	173	14.4
Engineering	67	5.6
Natural Sciences, including Agricultural and Veterinary Science	337	28.0
Medicine	278	23.1
<i>Total</i>	977	81.3
<i>Missing</i>	225	18.7

Naturally, those who responded were in different stages of their educational programmes, or subsequent employment. Table 3 presents the respondents' stage of education.

Table 3. Stage of education. N = 1202, n = 1202.

"At what stage are you in your education?"	Frequency	Percent
Ongoing	350	29.1
Dissertation finished	119	9.9
Received PhD	627	52.2
Studies terminated without PhD	73	6.1
Other	33	2.7
<i>Total</i>	1202	100

The results in Table 3 represent the current situation of the respondents (with reference to their PhD education). This is important background information in order to understand answers to other questions. There is nothing remarkable concerning the results presented in Table 3. The respondents belong to two annual cohorts, which were registered as PhD students in 1998 and 2002 respectively. Naturally, many of the 2002 cohort are still involved in their educational programme, whereas it is reasonable that many of the 1998 cohort have finished their programmes.

Expectations of the PhD education

What expectations do students have when they enter a PhD programme? What do they want their education to lead to? Which kind of work are they aiming at? In the questionnaire, the students were asked "What factors played a role in your decision to start a PhD education?". A few alternatives were provided. Table 4 presents some of the answers to this question.

Table 4. Interest in research, percent. N = 1202, n = 962

Interested in research	The area of science					
	Humanities	Social sciences	Engineering	Natural sciences	Medicine	All
Crucial importance	58.9	46.0	43.5	46.0	59.1	51.3
Significant importance	27.4	42.5	43.5	35.9	28.3	34.4
Some importance	13.7	9.8	8.7	15.5	11.5	12.7
Small importance	0.0	1.7	2.9	2.6	0.3	1.6
No importance	0.0	0.0	0.0	0.0	0.3	0.1
Total	100	100	100	100	100	100

The answers indicate the students were highly research oriented. Every second respondent expresses his/her interest in research was of "crucial importance" for the decision to enter a PhD programme; one third report it was of "strong importance". There are no remarkable differences between scientific areas. Participants were also asked if they wanted to qualify as a researcher, and they strongly agreed with this.

The result is somewhat surprising; one could have predicted a greater variation in their answers, especially when the possibility of getting a job that did not emphasise research would also be of strong interest. One might also suspect that many chose to start a PhD education because of a competitive job market with few possibilities of employment after completing a master's programme. Many of the respondents belong to a cohort that suffered from a sharp decrease in the number of industrial jobs after the financial downturn in early 2000. The self-evaluations confirm that it has not been easy to get jobs outside of academia, especially for graduates from the social sciences and the humanities. These assumptions were tested with the statements "I wanted to improve my competitiveness on the job market outside of academia", and "I could not get satisfying employment with my master-exam". As for the first statement, there is some support but it is neither strong nor weak; most respondents reported medium strong support. Regarding the second statement, the support is very weak. Thus, there is no clear indication that the respondents would have started their PhD education for reasons other than to learn research skills.

These questions were complemented by a question aimed at those participants who had completed their PhD theses: "What was your primary career goal right after having completed your PhD?" A

substantial 36% responded their goal was to be a researcher/teacher at university, 10% a researcher in another public sector and 18% a researcher in the private sector. 5% wanted to conduct research abroad. Altogether, about 70% had research-oriented work as their primary goal. This result confirms the strong orientation towards research as the prime motivation for undertaking a PhD education.

Table 5. Priorities after receiving PhD. N = 1202, n = 743.

"What was your highest priority after receiving your PhD?"	Frequency	Percent
Researcher/teacher at university	271	36.5
Researcher in other public sector	72	9.7
Researcher in the business world	135	18.2
Career within the profession	154	20.7
Administration, planning within the public sector	11	1.5
Administration, planning within the business world	22	3.0
Research and teaching abroad	38	5.1
Other	40	5.4
<i>Total</i>	743	100

It is of interest to see where the PhD students ended up after having completed their training. Did they get research-oriented jobs afterwards, as they had hoped? Table 6 presents the distribution of the present work situation regarding the public sector for those who have completed their PhD degrees. A similar table for the private sector is not meaningful due to low frequencies. Among those who have gone into the private sector, many are in the medical or electrical branches. Only a very few are in branches like the food industry, machinery or the chemical industry. Fifteen individuals reported that they have left Denmark, some for work, but some for other reasons.

Table 6. Distribution of current employment within public sector. N = 1202, n = 517.

Information on current employment: public sector	Frequency	Percent
University	261	50.5
Sector research institution	55	10.6
Archives, libraries and museum	4	0.8
Other public institution with research	15	2.9
Hospital	122	23.6
Educational institution outside university	27	5.2
Public administration	14	2.7
Other	19	3.7
<i>Total</i>	517	100

In addition, participants were asked what they do at their present job, which functions they have? The findings confirm that a majority of them do perform research-related functions, or do research in combination with teaching. Table 7 presents the distribution of answers on a range of categorised functions.

Table 7. Main function at current position. N = 1202, n = 749.

"What is your main function at your current position?"	Frequency	Percent
R&D	250	33.4
Research combined with teaching	163	21.8
Leading R&D	34	4.5
Other type of leadership	10	1.3
Teaching	42	5.6
Clinical functions	92	12.3
Managing	13	1.7
Consulting	41	5.5
Other	46	6.1
No employment	58	7.7
<i>Total</i>	749	100

It should be noted regarding Table 7 that "No employment" does not necessarily mean unemployed; 7.7% is a rather high figure, and it is highly likely that people on parental leave are included here.

Supervision

"Good" supervision is often a crucial factor for success and satisfaction with the research training and the thesis-writing during the PhD education. It is important to have a sound relationship with a supervisor that works for both components. This has much to do with personal chemistry and the relationship can be everything from formal to informal or non-frequent top-down advisory meetings to collegial collaboration within a tight research group. The idea of a master-apprentice relationship, which may have been the dominant kind of relationship previously, is slowly fading out in favour of a more collegial relationship. Still, the supervisor is there to give advice and comment constructively on the student's work.

Supervision is also about introducing students to a scientific context, a scientific environment and scientific thinking. Moreover, students ought to be presented to scientific networks and be acquainted with Danish and foreign colleagues working in the same field of study. Introducing students to senior colleagues at conferences, co-authoring journal articles and writing recommendation letters are functions that supervisors often perform. They are not always formally required, but nevertheless frequently are done, depending on the relationship that the student and the supervisor have, and they are by and large signs of good supervision. Much is written about this relationship and it is easily understood that it has to be a personal relationship, which is difficult to formalise fully. However, parts of it can be formalised and regulated requirements can be used to set the norms and stipulate the broad characteristics of the supervisor-student relationship.

Closely related to supervision is the project plan for the PhD thesis, supplemented with periods of coursework, teaching or other institutional work, and often a period studying at another institution. Naturally, it is important to create an individual plan for the PhD studies as early as possible. This is done in most cases, but as many as 28% of the participants reported that some 6-9 months after starting their PhD studies, they had not yet made such a plan. This result must be regarded as dissatisfactory.

The respondents were asked to grade the quality of the supervision they had gotten on a five-point scale ranging from "bad" to "very good". Table 8 presents their responses, by stage of education.

The students were fairly satisfied with the quality of their supervision. Two thirds reported it as good or very good. Only a small share reported it was bad. According to the self-evaluations, there is seldom any formalised education or coursework related to the duties of supervisors. All professors and associate professors in principal are qualified as supervisors. Some sort of "mentor-package" coursework could be considered, although the present situation and level of satisfaction reported by the students hardly stress the importance of such up-grading of the supervisors' skills.

Table 8. Quality of supervision. N = 1202, n = 1194.

"At what stage are you in your education?"	"How good was the quality of the supervision received?"					Total
	Very good	Good	Medium	Less good	Bad	
Ongoing	6.87	11.89	6.45	2.43	1.59	29.23
Dissertation finished	3.10	3.60	1.68	1.26	0.25	9.88
Received PhD	18.09	18.68	8.79	5.03	1.68	52.26
Studies terminated without PhD	0.67	1.93	1.51	1.17	0.67	5.95
Other	0.59	0.67	0.84	0.50	0.08	2.68
<i>Total</i>	29.31	36.77	19.26	10.39	4.27	100

It is possible to have more than one supervisor. There can be one main supervisor at the department or the research school where the student is registered, but in addition there can be other supervisors, at the same or other institutions. On average, the PhD students in this sample have had two supervisors who carried out formal supervisory functions during the students' graduate study. About every second respondent had one or more supervisors at institutions other than the one where they were registered. From the universities' perspective, it should be noted that external supervisors are usually found to be useful as supplements to the internal supervisors' competence. The quality assessment of external supervisors is positive.

Estimations of the quality of supervision can be measured by how easy it is to get in touch with the supervisor, and how frequent their contact is. In order to investigate this a bit further, we wanted to determine how often supervisors contacted students, and if there was a difference between the main supervisor at the home university, and supervisors outside of that university. There was great diversity in the frequency of supervisor contact with students. About one third of the PhD students had been contacted at least once a week, indicating rather frequent contact from their supervisors. On the other hand, about one third had been contacted less than once a month, which must be

regarded as fairly infrequent contact and a practice that ought to be improved. There was very little difference between primary supervisors at the home university and supervisors outside of the university.

Table 9. Contact with supervisors. N = 1202, n1 = 1190, n2 = 521.

Contact frequency	"How often did your supervisor contact you?" (Supervisor at the university, n1)		"How often did your supervisor contact you?" (Supervisor outside of the university, n2)	
	Frequency	Percent	Frequency	Percent
Daily or almost daily	95	8.0	44	8.4
Many times a week	191	16.1	56	10.7
Once a week	160	13.4	76	14.6
Once or a couple of times a month	374	31.4	144	27.6
More seldom	370	31.1	201	38.6
<i>Total</i>	1190	100	521	100

But the need for supervision is not evenly distributed. There are periods when supervision is not that urgent. The need for supervision is furthermore heavily dependent on the topic of study, personality characteristics and whether there are additional supervisors or other colleagues around. Perhaps it is more important to be able to see a supervisor when one feels the need oneself. As many as 42% stated that they could always get in touch with their supervisors when they wanted to. Another 49% reported that they could do so most of the time. These must be regarded as fully acceptable figures, which indicate an open and non-restricted situation at Danish universities in regards to approaching supervisors.

Table 10. Need for contact with supervisor. N = 1202, n = 1194.

"Were you able to contact your supervisor when needed?"	Frequency	Percent
Yes, always	499	41.8
Most of the time	590	49.4
No, often a problem	90	7.5
No, it was too hard	15	1.3
<i>Total</i>	1194	100

To examine this issue a little closer, the students were asked how valuable the amount of supervision was for them. Did they get enough supervision? In general, the students reported that they felt they got the supervision they needed, i.e., over 60% were satisfied. A little more than one third of the students felt that there was a need for more supervision. Although the figures indicate a generally positive attitude, there is room for further improvement: 90% reported that they could see their supervisors when they needed to, but only some 60% felt that they got enough supervision; and 66% rate the quality of their supervision as Good or Very good. The figures indicate a gap, although not severe in any respect. It is possible that some supervisors have too many PhD students and thus do not have time to provide them with substantial reading comments etc. Even though they may be available, the quality of their supervision might be low. Further investigations are suggested in order to get a clearer picture of the circumstances.

It might be predicted that the supervision occurring in the research schools generally is of higher quality than elsewhere, because these schools represent an effort to improve the PhD education, thus focusing on the content of the education as such, and finding good forms for education and research training. Their interest in the various components of a PhD education can be assumed, and thus an interest in supervision as well, and its importance. Are PhD students registered at research schools more satisfied in general with their supervision than others are? Tables 11, 12 and 13 present some findings related to this question.

Table 11. Quality of supervision at graduate schools and elsewhere, percent. N = 1202, n = 1191.

"How good was the quality of the supervision received?"	"Are/were you registered at a graduate school during the course of your education?"			
	No	Yes	Do not know	All
Very good	31.7	28.3	27.6	29.4
Good	36.8	36.6	35.7	36.6
Medium	18.9	19.3	21.4	19.3
Less good	8.1	11.8	10.2	10.4
Bad	4.5	4.0	5.1	4.3
<i>Total</i>	100	100	100	100

Table 12. Contact by supervisor at graduate schools and at own university, percent. N = 1202, n = 1187

"Are/were you registered at a graduate school during the course of your education?"				
"How often did your supervisor contact you via telephone, email etc?" (Supervisor at the university)	No	Yes	Do not know	All
Daily or almost daily	7.6	8.2	8.2	8.0
Many times a week	14.0	16.1	24.5	16.1
Once a week	12.4	13.8	15.3	13.5
Once or a couple of times a month	31.7	31.2	30.6	31.3
More seldom	34.3	30.6	21.4	31.1
<i>Total</i>	100	100	100	100

Table 13. Need for contact with supervisor at graduate schools, percent. N = 1202, n = 1191.

"Are/were you registered at a graduate school during the course of your education?"				
"Were you able to contact your supervisor when needed?"	No	Yes	Do not know	Total
Yes, always	42.1	42.6	36.4	41.9
Most of the time	49.7	48.0	56.6	49.3
No, often a problem	6.9	8.2	6.1	7.6
No, it was too hard	1.3	1.3	1.0	1.3
<i>Total</i>	100	100	100	100

According to the results presented in Tables 11-13, there are essentially no differences between those who were registered at a graduate school and those who were not, in terms of perceived quality of supervision, the frequency of contact with supervisors and the ease of getting in touch with supervisors when needed. There is thus no evidence that supervision is better at a graduate school setting than it is in traditional PhD education within the framework of departments.

Another hypothesis was tested to determine if students who had not established an individual study plan during the first six to nine months were also more dissatisfied with their supervision. It seems

possible that there might be a connection and that these students and their supervisors have failed in some way regarding the contact and outline of the PhD education as such. Table 14 examines the link between the timing of individual study plans and whether it was possible to contact supervisors when needed.

Table 14. Study plan and contact with supervisor, percent. N = 1202, n = 1188.

"Were you able to contact your supervisor when needed?"	"Was an individual plan for the studies established during the first 6-9 months?"		
	No	Yes	Total
Yes, always	33.0	45.2	41.8
Most of the time	52.9	48.2	49.5
No, often a problem	11.9	5.8	7.5
No, it was too hard	2.1	0.8	1.2
Total	100	100	100

There is some evidence of a trend; students who did establish individual study plans also found it easier to contact their supervisors when they needed to, but the differences are surprisingly small and their implications should not be exaggerated. It remains unclear why some students are happier with their supervision than are others. Personal chemistry and individual circumstances may be better explanations in this case than structural matters.

Coursework

Besides the actual research training and thesis writing, participation in courses often occupies a significant part of a graduate student's education. The Danish faculties' self-evaluations indicate that many departments and graduate schools require coursework lasting approximately half a year. How many courses do the PhD students take? Do they take courses at institutions other than their own? What do they think of the quality of the courses? Are they relevant?

On average, the PhD students participated in 4.2 courses at the institutions where they were registered. Approximately 4.0 of these were credit-giving courses. It is unclear whether the difference refers to participation in other than credit-giving courses, or if it refers to drop-outs from courses without earning the points.

The students also participated in courses at other institutions. The number is slightly lower than it is for their own institutions: 3.3 courses on average had been undertaken at other institutions, and 3.1 of those resulted in course credits for the student.

How do the PhD students evaluate the *quality* of the courses? Table 15 presents estimates of the quality of the courses at their home institutions and at other institutions. Quite clearly, they think that the quality of courses is generally high. Very rarely do they judge the quality as poor. There is a small difference in each step of the estimates of about 5% towards higher quality at other institutions.

Table 15. Quality and relevance of courses. N = 1202, n1 = 1044, n2 = 983.

Quality	Quality of courses at own institution, n1		Quality of courses at other institutions, n2	
	Frequency	Percent	Frequency	Percent
Very high	110	10.5	155	15.8
High	568	54.4	589	59.9
Medium	313	30.0	219	22.3
Fairly low	41	3.9	12	1.2
Low	12	1.1	8	0.8
<i>Total</i>	1044	100	983	100
<i>Missing</i>	158		219	

In order to examine these results a little further, the students were also asked to grade the *relevance for the PhD education* of the credit-giving courses they had undertaken. Similar to the figures in Table 15, the students graded the relevance as generally high, although not as high as quality. Again, there is an apparent difference in the responses, where relevance of courses at other institutions are graded some 7-8% higher than at the home institution, at each step.

The students furthermore were asked about the *relevance of courses for their future career*. This time, the students' estimates are towards a medium rating rather than clearly high as found regarding quality and relevance to education. Still, very few graded the relevance of their courses for their future

career as low. Yet again, there is a difference in the responses of around 5%, with higher appreciation of courses at other institutions than at their own.

One can interpret these findings as suggesting that the PhD students really appreciate the courses they participate in. They think that the quality and the relevance of the courses for their studies are high. They participate in a fair number of courses during their studies. The courses that they undertake at other institutions are regarded as of slightly higher quality and relevance than are the courses at their own institution. This small but repeated difference might be because students are more selective when they decide to take a course at another institution. Not all of the PhD students are sure that their courses are relevant for their future career. This is somewhat difficult to explain as we noted earlier that a majority of the PhD students have a research and teaching career in mind as the outcome of their studies. Possibly, the courses are perceived to have an immediate relevance for their research training but not a long-term relevance to their subsequent profession.

International experience

A little over half of the PhD students (52%) had undertaken a period abroad at another institution during some part of their PhD education. On average, this period lasted about five-six months. Only 11% claimed that they mainly participated in course- or teaching-related activities during their time abroad, 74% worked mainly on their own research projects, and 10% worked mainly on other research. A small proportion participated in other activities.

Figure 2 shows the countries the PhD students chose to go to. A few (5.7 %; 35 out of 613) reported that they had been to more than one country, and for them, each country has been given one full count. There is a great concentration and a great variation at the same time in the travel pattern. The dominance of the United States and the United Kingdom as host countries is very heavy, naturally a consequence of the size and quality of their university systems and the high scientific standards of many universities in these countries. It is also due to advantages in terms of language.

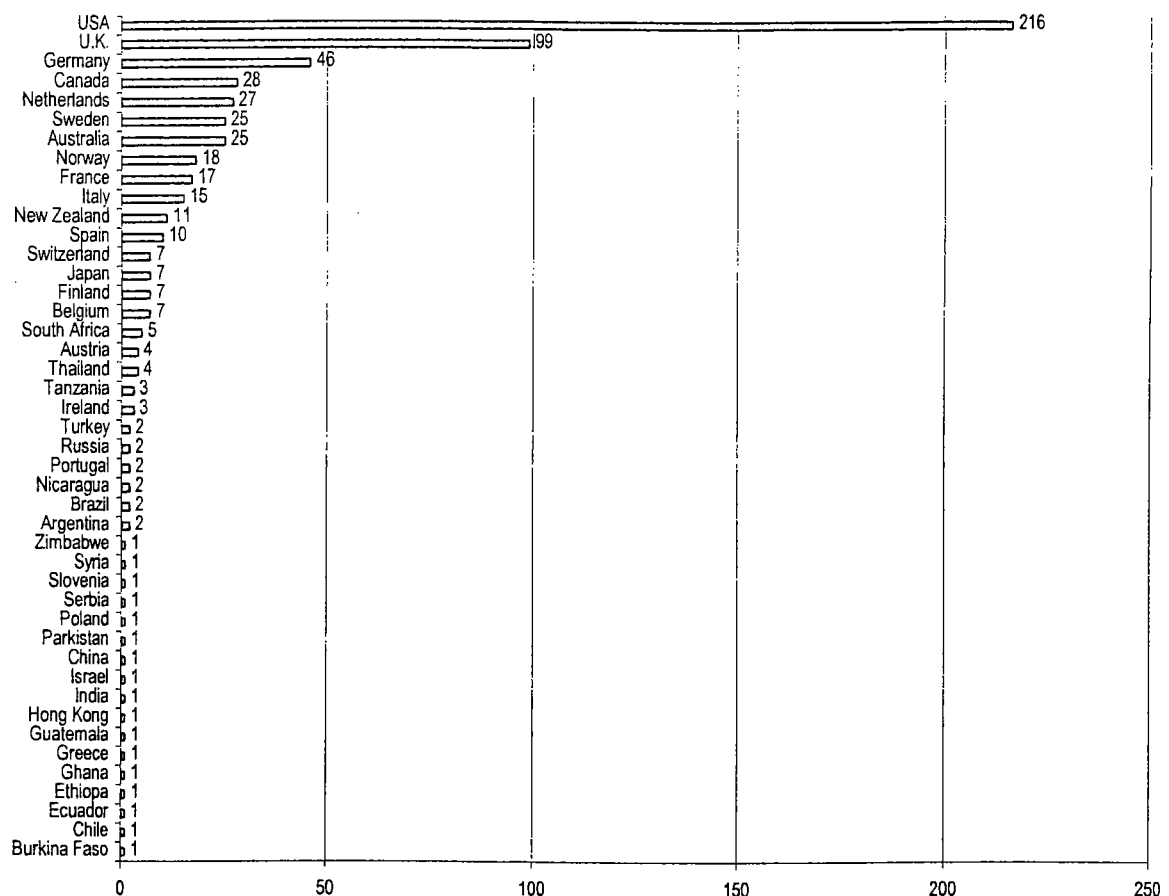


Figure 2. Distribution of host countries for PhD students from Denmark. N=613.

Interestingly, 59% claimed that their home institutions had no research contacts with the host institutions of their choice before they went there. Those who answered that there were research contacts were asked what type of contact it was. A small number reported that the contact originated in project-based research or teaching cooperation (5.3%). More frequently, the contact was built upon personal contacts that colleagues had with the institution abroad (15%). Very rarely, it was a colleague or the PhD student him- or herself who had knowledge about the foreign institution but without contacts already made (1.6%).

It is clear that the PhD students valued their stay abroad: 75% rated it as being of high or very high benefit to their education, 6% rated it as having low benefit, or none. The students were also asked to make comparisons between Danish PhD education and the PhD education they encountered abroad. Regarding the *resemblance of requirements* as well as its *quality* and *efficiency*, they generally perceived the foreign PhD education as fairly equal to the Danish PhD education: about one fifth (18-20%) thought Danish education was better, one fifth (16-21%) thought it was of lower quality, and one fifth responded that they did not know (20-21%). The rest (37-46%) regarded the Danish education to be similar to the foreign one, with respect to the three mentioned aspects. Hence,

there is no tendency to favour or disfavour Danish PhD education in comparison with education abroad.

Table 16. Evaluation of going abroad during PhD education. N = 1202, n = 571.

"How do you value going abroad in relation to your PhD education?"	Frequency	Percent
Very beneficial exchange	248	43.4
Beneficial exchange	181	31.7
Some beneficial exchange	108	18.9
Low beneficial exchange	29	5.1
No beneficial exchange	5	0.9
<i>Total</i>	<i>571</i>	<i>100</i>

All in all, the PhD students were very happy with their stay abroad and valued it highly. They also regarded the Danish PhD education as equally good in comparison to the foreign educational programme they had encountered. There is no tendency towards either higher or lower appreciation of foreign education.

One additional comment can be made regarding Figure 2. The figure can be seen as a picture of Danish contact surfaces for PhD students. Scientific contacts made early, during the formative years of a scholar or a scientist, can be argued to be important for the future development of international collaborations, and participation and communication in international scientific networks. Therefore, the travelling pattern should not be too disproportional to the distribution of countries that are generating scientific knowledge. It may be important for Danish PhD students to connect with the best scientific environments in their respective fields, wherever they are in the world. But at the same time, it may be important to connect with environments that will be strong scientific environments tomorrow, even if they are not there today. Thus, the travel pattern ought not to be too narrow or too converged. Neither should it be too diffused and without enough connections to leading scientific sites. It should include upcoming scientific nations and universities as well as traditionally strong ones.

Figure 2 reveals a potential problem for Danish scientific activities from a long-term perspective. A fair number of contacts were made with established Western nations and there is contact with a

wide range of small countries in other parts of the world as well. But, there is a handful of countries that the next generation of Danish scientists most likely already today should develop contacts with, but which are absent in the data.

One PhD student visited China, one visited India, and two visited Brazil. None of the PhD students went to South Korea, Mexico, Singapore, or Taiwan. Countries like these have highly developed university systems and scientific centres of world class in selected areas. As their science systems have been in a phase of rapid growth and development for at least a decade, it is important for Denmark to connect with them and establish information exchange and research collaboration in order to take part in new knowledge and technological discoveries. There is reason for the senior generation not to have established contacts with these countries before – they were still undeveloped in scientific terms twenty years ago – but the younger generation has to establish such contacts. Being early is surely an advantage. This should be part of future monitoring and evaluation of PhD training.

Finances and overall satisfaction

A few words are required about the amount of available expenditures that PhD students have. Normally, students have lump sums attached to their positions, which can be used for travel, conferences or equipment. However, not everyone is aware of this, for example how much is available or how the funding may be used. Actually, almost half of the students (47%) were not aware of the size of the disposable funds.

The PhD students were asked if they had found the amount of expenditures reasonable. The result was highly positive: 32% reported that the funds were definitely reasonable, another 46% claimed that they basically were reasonable; and only 21% reported that funding was barely reasonable, or not at all.

Table 17. Disposable funds for necessities during education. N = 1202, n = 1181.

"Did/do you have reasonable funds for the necessities of your PhD education?"	Frequency	Percent
Yes, definitely	382	32.3
Yes, basically	553	46.8
No, just barely	172	14.6
No, not at all	74	6.3
<i>Total</i>	1181	100

It might be interesting to see if there were any differences in opinion regarding the amount of disposable funds between those who actually were aware of how much they have, and those who were not. Table 18 indicates that students who had been aware of the funds were somewhat more satisfied with the amount, while those who were not aware of the funds were somewhat less satisfied. Whether they used what they had available is unknown to us.

Table 18. Awareness of funds and satisfaction with the funds. N = 1202, n = 1174.

"During your education, have you been aware of the size the disposable funds?"	"Did/do you have reasonable funds for the necessities of your PhD education?"				<i>Total</i>
	Yes, definitely	Yes, basically	No, just barely	No, not at all	
No	24.4	50.5	17.4	7.8	100
Yes	39.3	43.8	12.0	4.9	100

Were the students' overall expectations regarding the PhD education fulfilled? Are the Danish PhD students satisfied with their education? The respondents were asked whether their expectations concerning their PhD education had been met regarding *qualifications, career prospects* and their *present job*. Table 19 presents the results.

Table 19. Expectations concerning education. N = 1202, n1 = 742, n2 = 733, n3 = 698.

	"Has your PhD education fulfilled your expectations regarding qualifications?" n1		"Has your PhD education fulfilled your expectations regarding career?" n2		"Has your PhD education fulfilled your expectations regarding current employment?" n3	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
To a high extent	428	57.7	303	41.3	340	48.7
To some extent	287	38.7	313	42.7	267	38.3
To a small extent	23	3.1	78	10.6	59	8.5
To no extent	4	0.5	39	5.3	32	4.6
<i>Total</i>	742	100	733	100	698	100

The respondents were generally very happy with the education they obtained. Half of the respondents reported that the training met their expectations to a high extent and only very few claimed the opposite. Naturally, this is related to the fact that they had some idea of what the PhD education would lead to, and after having completed the training they have very often succeeded in getting a position where they wanted.

The average length of a PhD education is dependent on a range of circumstances; not the least, if one is admitted to a three-year or a four-year programme. Sickness, parental leave and other circumstances effect the length of time needed to complete the degree. The PhD students were not explicitly asked how much time their education took. Such figures are available elsewhere for the Danish students, and there is so far no indication that the time frame is significantly extended beyond the expected three or four years for other than legitimate reasons.

Instead, the respondents were asked to specify how much time they have spent on various parts of their education. Table 20 presents the findings. On average, 4.5 months were spent on coursework and about five months on teaching and tutoring. Nearly two full years were spent on their dissertation research. A few months were spent on other work and activities.

Table 20. Disposition of time during course of education⁸, months. N = 1202.

	n	Mean	Std. Deviation
Number of months spent in courses	1074	4.3	2.4
Number of months spent on teaching and tutoring	1050	4.6	3.2
Number of months spent on own research project	1063	22.8	7.7
Number of months spent in operating, development of research projects other than own project	929	3.5	3.2

One issue is whether coursework, teaching and project work are generally given the time that is most optimal for the students – and for the system as a whole. Are two years enough for completing an independent research project? Is approximately one semester of coursework reasonable? Should the mandatory institutional work occupy one full semester during a three-four year long education? The panel is quite convinced that the proportions must change. On the other hand, the number of months to be gained for the research project is limited. Rather, we would like to see a shift of emphasis from teaching and other institutional duties to coursework, which should be a more essential component of graduate studies.

Capacity

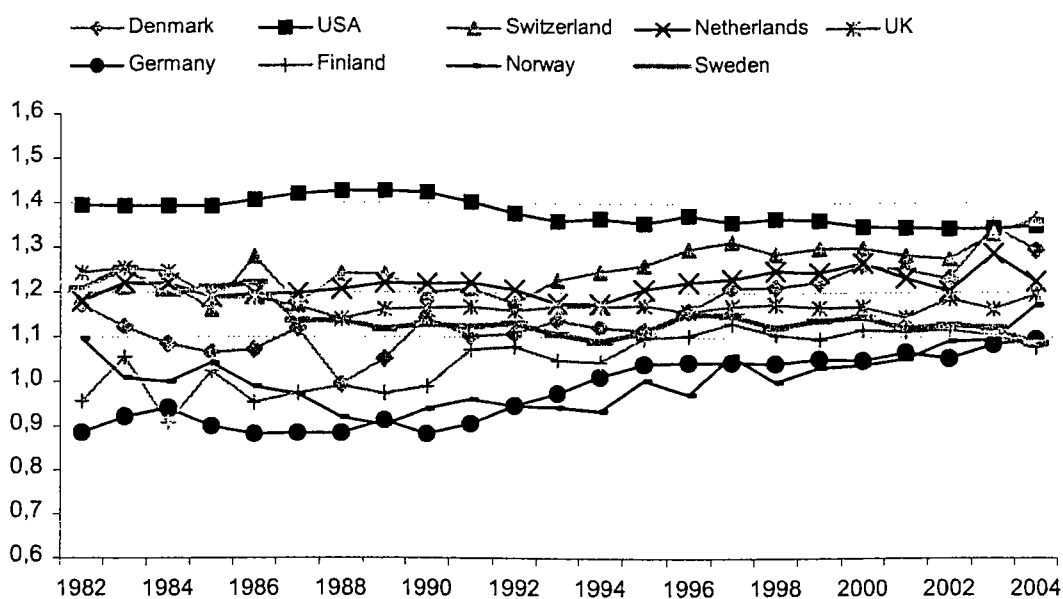
In the face of a major increase in PhD enrolment in Denmark, it is essential to consider issues of capacity. The faculty/PhD student ratio varies between institutions, but is on average not more than 1:1. Even considering the fact that some faculty members are not very active researchers or not well-suited to being supervisors, there is still room for more time and attention devoted to PhD training among faculty. If we assume (based on our site visits, interviews and available data) that 50% of the faculty are not very active in PhD training, the ratio is still only 1:2. A typical ratio in the best American graduate schools is 1:4, i.e., one professor works with four graduate students.

There is, generally speaking, a capacity for expansion of PhD training in the Danish university system. Increased enrolment of PhD candidates therefore is attainable without far-reaching changes in faculty structure or volume. Danish faculty, however, should enhance their individual capacities

⁸ Some extreme response values were regarded as invalid and left out, and this is why the mean value and standard deviation were calculated using only 99% of the available answers.

to serve as supervisors and leaders of PhD education, and will need support in this. Capacity should also be directed towards organisation and leadership, notably in the responsible build-up of solid graduate schools.

Even though the Danish universities do not need to hire new faculty to accommodate more PhD students, they will have to devote a larger share of their time to PhD training. This time will mostly be taken from research. An increase in PhD education means, therefore, a diminishing volume of senior research. This may result in negative impact on scientific performance as measured by conventional bibliometric indicators. In this respect, Denmark has performed extremely well over the past two decades (Figure 3).



	Denmark	USA	Switzerland	Netherlands	UK	Germany	Finland	Norway	Sweden
1985	1.07	1.39	1.16	1.19	1.19	0.90	1.02	1.04	1.21
1990	1.14	1.42	1.20	1.22	1.17	0.88	0.99	0.94	1.13
1995	1.12	1.36	1.26	1.21	1.17	1.04	1.10	1.00	1.11
2000	1.26	1.35	1.30	1.27	1.17	1.05	1.12	1.04	1.14
2001	1.25	1.34	1.28	1.23	1.14	1.07	1.11	1.05	1.12
2002	1.23	1.34	1.28	1.20	1.19	1.05	1.12	1.09	1.13
2003	1.35	1.34	1.33	1.29	1.16	1.08	1.10	1.09	1.12
2004	1.30	1.35	1.37	1.22	1.20	1.10	1.08	1.17	1.09

Note: Crown indicator = citations per article from a certain country (in this case) in any given subject area divided by average citations in that subject area. This measure comes close to the more traditional RCI (Relative Citation Impact, measured as a country's share of the total number of citations in any given subject area divided by the country's share of the total number of publications within the same area; RCI = 1.00 is average) (van Raan, 1996, 2004).

Figure 3. Crown indicators for top performing countries 1982-2004. Source: The Swedish Research Council based on data from Thomson Scientific.

The perhaps most important overall trend is the convergence among leading countries, and the catching up that is going on in Europe vis à vis the United States. Most European countries have been improving their performance, an exception is Sweden. Denmark and Switzerland demonstrate the most significant improvement and occupied the top positions in 2003 and 2004 respectively. It is generally quite difficult to explain relative changes of research performance. One possible explanation that has been proposed is that increased portions of PhD publications could affect performance in a negative way due to decreased research time for faculty. However, the assumption that an increased proportion of PhD articles might affect total research quality should not, in our view, prevent Denmark from expanding its PhD education. First, it is just an assumption, second, counter measures could also be taken. The way graduate research is integrated into research groups and the way co-publication with supervisors and colleagues is conducted could affect quality in a positive way.

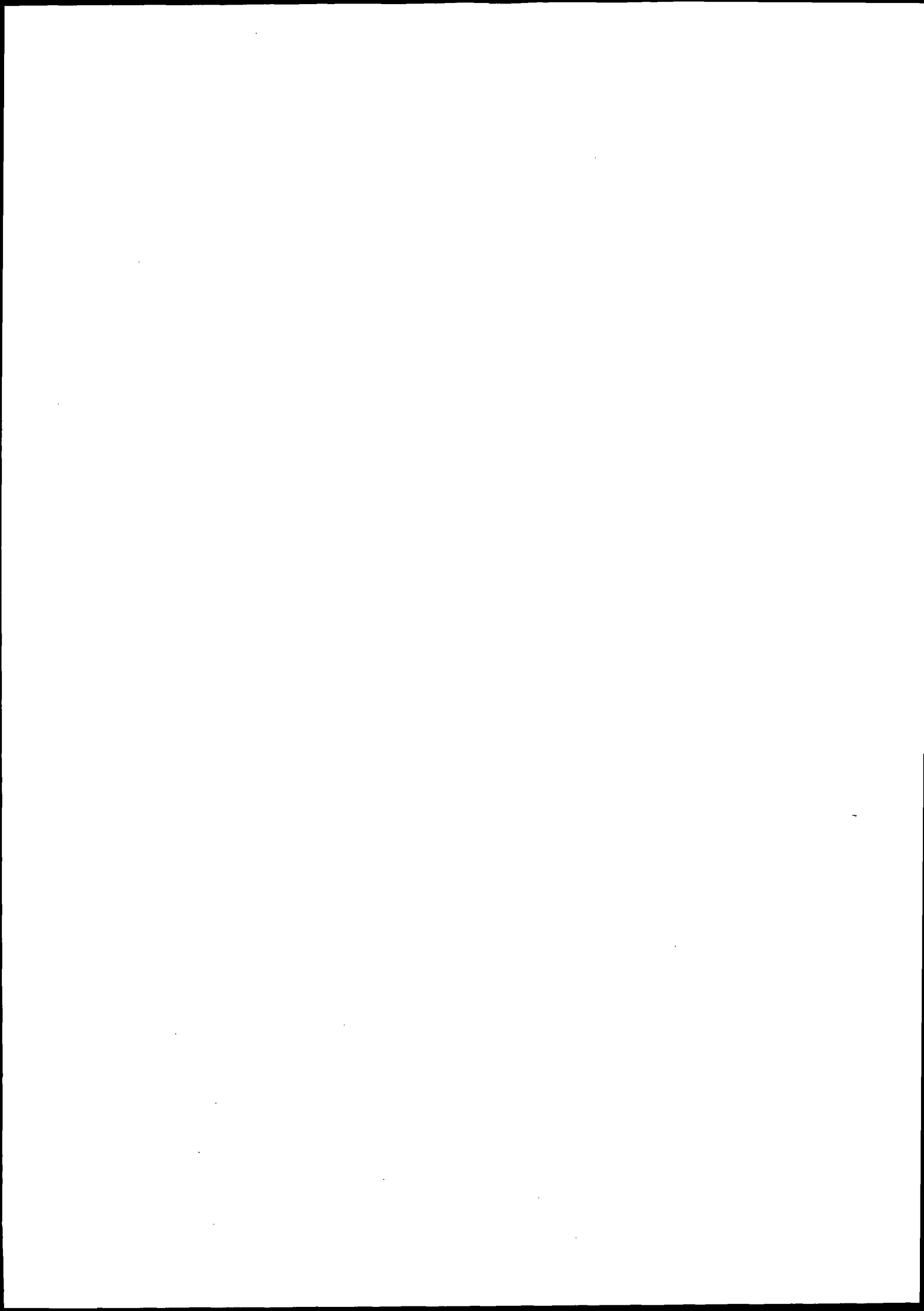
The special case of medicine

Today there are three universities that provide PhD programmes in medicine: the University of Copenhagen, the University of Aarhus, and the University of Southern Denmark. Additionally, Denmark's Pharmaceutical University offers a PhD programme within the pharmaceutical area (e.g., within the Drug Research Academy).

There has recently been a revision of the pre-graduate education in medicine in Denmark. The training is highly focused on clinical practice, not research, and thus doctors are considered to a large extent to be "research-naïve" when they graduate with their medical degrees. There is no in-depth specialisation of any length built into the education at this level. Therefore, it is of significant importance that those who continue with a PhD education in medicine face a mandatory course package that includes methodology, ethics and philosophy of science, as an introduction.

Reports from the Boston Consulting Group have pointed out at least three medical areas where Danish research meets the highest international standards: endocrinology, neurological sciences, and immunology. As these areas to a large extent overlap with the fields that the pharmaceutical industry in Denmark is focusing on, it should be considered whether national graduate schools in these respective areas would be a good idea, combining graduate schools in each university. A particular benefit of this might be to diminish rivalry between the universities, for instance, between the medical faculties in Copenhagen and Aarhus. A unification of the national resources, rather than battles between them, is likely to have significant marginal effects. Such a concentration of the

resources in general, and profiling at the universities, together with increased cooperation instead might be a way to establish the critical mass that is often believed to be necessary for a high level of research. This may be more valuable in some medical areas than in others.



4. Graduate Schools – the Norm of International Quality

There has been considerable interest in graduate schools (*forskerskoler*) in Denmark in recent years. The number of such schools has grown from virtually zero in the late 1990s to ca 150 in late 2004 and the numbers are still growing. Graduate schools now exist in all universities in Denmark. Graduate schools have been the object of a new funding scheme to establish a more formal PhD education with higher quality. The goal was to use the graduate school as an instrument to increase the quality of the PhD education. We believe its role is so important that we would like at some length to discuss its characteristics and its Danish peculiarities before moving to a discussion on how it could be changed to work efficiently in the future.

The concept of graduate school

The European appropriation of the concept of “graduate school” represents one of the more astounding transatlantic cultural imports. The European use of the term “graduate school” to identify local PhD training and education is basically a blunt misinterpretation. In many European countries, Denmark included, “graduate school” is used to identify the actual PhD programme with its courses, advising structure and organisational form.

It is obvious that the Danish term for graduate school, *forskerskole*, is conceptually very different from its application in major research universities in the United States. It is not paralleled in the British university system either. In both the British and the US university systems, a graduate school, as it stands out in the most prestigious universities, is actually an administrative body responsible for handling the administrative tasks of graduate education (master’s, professional master’s, PhDs and other doctoral programmes). It is a place to send an application, it is a place where tuition and fees are paid and it is a place where potential grievances between student and university are negotiated. Each university has only one graduate school and the different PhD programmes are organised under this administrative body. On the other hand, the graduate school has little or no impact on the substantial content of the PhD programmes.

Basically, the Danish appropriation of the term “*forskerskole*” resembles what in the US would be identified as a PhD programme. This means for example a programme in chemistry, computing, or science and technology. The professional provider of content under the US/British system, and advising, is always the responsibility of the separate PhD programmes. In a broader perspective, it

is obvious that the PhD education process is quite diverse. Most of the programmes in Anglo-American higher education are discipline based. The students view the programmes as the setting where the members of their thesis committees (usually three persons) can be approached and for social, self-organisation among peer students.

The Danish graduate school differs from this model on some very important issues. Still, we will from now on use the term "graduate school" when we speak about the Danish variant of a graduate school. The reader has to keep in mind that the US/British connotation of graduate schools differs from what we encounter in the Danish context.

The Danish graduate school was created in 1996 as an experiment aiming at improving the PhD education. The effort was intensified in 2000 with added economic support. The initial experimentation met some resentment, but new funding opportunities were launched and by the end of 2004, 140 graduate schools had been created, with 3,600 PhD students or 73% of the total PhD enrolment in Denmark.⁹ The number of graduate schools is still increasing.

A graduate school is characterized by the following (according to the first call for applications in 2005 from the Danish Research Coordination Committee (*Koordinationsudvalget for forskning, KUF*):

- It is an organisational unit with well-defined leadership.
- It gives a structured, coordinated, and integrated PhD education.
- It cooperates with academic and non-academic institutions.
- It creates a large enough environment (students and academic discourses) that enables broad learning and opportunity for reflection.
- There is a wide variety of approaches, the PhD study can be discipline-based or multidisciplinary, research objects can be of different kinds, research could be theoretical or applied, methodologies can vary.

This list is quite ambitious from the perspective of what a graduate school actually should accomplish. It is important to bear in mind that each graduate school receives on average less than DKK 2 million as financial support for administrative and educational purposes. The average student number is 25, which is indeed very little compared with the international exemplars. Apart from size and funding, there are three elements that stand out as being different from the US/British based graduate schools. First, a Danish graduate school can incorporate institutions outside of the academic world. Second, leadership is identified as a viable element. Third, it often

⁹ *Kortlægning af forskerskoler*, Forskeruddannelsesudvalget (September 2005).

creates a larger community of students and teachers/advisors. In fact, these three elements can be understood as a Danish contribution to innovations in PhD education.

The most radical break is the inclusion of non-university institutions in a PhD-based research training. Emphasising leadership and organisational structures as important elements in a PhD programme is also worth noting simply because such issues usually are overlooked or paid little attention to in higher education. The way work is organised (how the teaching/advising operate) is usually not examined at all, even though it is clear that one cannot separate content from performance and structure.

Graduate schools in the Danish context

Graduate schools since their creation in 1996 have turned out to be an important instrument in the Danish PhD system. It is therefore of vital interest to make sense of how the reform has impacted local PhD training. A mapping of the activities in the different graduate schools was published by The Danish Research Coordination Committee in 2005. A major concern in that report was the problematic future funding situation, both in terms of support for organised graduate school activities and funding for enough stipends for PhD students. There are some amazing figures in this report. One in five (19%) have not yet established a leadership structure and 37% have not formalised the operation of the local "graduate school". Less than one in ten of the graduate schools have a fixed ceiling for the number of students a supervisor is allowed to take on. Only one school in seven provides training and advice for supervisors. Some graduate schools are mere paper tigers in the sense that they do not exert any formal influence on important decisions such as appointing supervisors or appointing examination committees.

These figures and features should be kept in mind in the following discussion. It seems plausible that at least one fifth of the schools hardly can be labelled "graduate school" in the original meaning, simply because the organisational structure and leadership is too vague – or absent.

The graduate school embodies the fundamental structure within which the PhD education takes place. The course curricula are created through the graduate schools and the graduate school actually frames the most powerful part of the informal crucial social and professional environment for PhD education through its formal structure.

The pedagogical structure of PhD training is grounded on three integrated elements. First, the course structure is aimed at providing a broad professional background. Second, advising is the key to designing a qualified research process and to writing up research findings either in the form of

papers or monographs. The third element of PhD training is the informal peer interactions and the possibility of relating to a broader group of highly skilled researchers. This basically requires a research environment of a certain size. Included in this social element are also the experiences from international research institutions.

Results from the survey of PhD students partly confirms that the situation is not always well-functioning. Of the PhD students who responded to the questionnaire, 58% had been or were registered in a graduate school. It is worth noting that as many as 8% answered that they "do not know" if they had been registered at a graduate school; 33% answer "no".

It would be very interesting to determine if and how the education in graduate schools differs from the more traditional structure undertaken within the frame of university departments. Responses to one question in the survey are slightly disturbing in regards to the establishment of an individual study plan during the first part of the educational programme. Everyone ought to have such a study plan. Is there a difference between graduate schools and departmental PhD education? Table 21 presents these findings.

Table 21. Individual study plan at graduate schools, percent. N = 1202, n = 1188.

"Was an individual plan for your studies established during the first 6-9 months?"	"Are/were you registered at a graduate school during your education?"			
	No	Yes	Do not know	not All
No	22.0	30.7	29.3	27.7
Yes	78.0	69.3	70.7	72.3
Total	100	100	100	100

Actually, the situation is a little worse at graduate schools than it is in the departments. A solid 31% of the students at graduate schools had not made up an individual plan during the first six-nine months, while the corresponding figure for students in departmental PhD programmes was 22%.

How about the half-year evaluations that are supposed to be undertaken throughout their studies? Are the graduate schools poorer at carrying them out as well? Table 22 presents the findings regarding this question. It can be seen that the graduate schools are slightly worse at conducting the half-year evaluations, but the differences are by no means dramatic: 10% at graduate schools have not had such evaluations every half year, while 6% at the departments claim not to have had them.

Table 22. Half-year evaluations at graduate schools, percent. N = 1202, n1 = 1185, n2 = 1066.

"Are/were you registered at a graduate school during your education?" n1				
"Did you have half-year evaluations during your education?"	No	Yes	Do not know	Total
No	6.1	10.0	10.3	8.7
Yes	93.9	90.0	89.7	91.3
<i>Total</i>	100	100	100	100
If Yes - what type, n2				
Evaluation of the content	39.1	38.5	33.7	38.3
Only formal evaluation	60.9	61.5	66.3	61.7
<i>Total</i>	100	100	100	100

In the self-evaluations of the Danish universities, which the evaluation panel has been provided with, the question was raised regarding the value of graduate schools, networks and centres as a means to develop and improve the PhD education. This frames the graduate school in a dynamic perspective, and does not judge the effectiveness or efficiency of the daily operations. The responses to this question can be divided in three equal categories.

1. *The supportive engagement*

"The organisation of research training in graduate schools, networks etc. is a very valuable tool to give the education a broader perspective. It promotes methodological and substantial skills ... and is the backbone of research education in the humanities..."

"The graduate school in general is judged to be extraordinarily positive, both in terms of regional/national graduate schools and graduate schools anchored at our university".

The two quotations are typical of the most positive attitudes concerning graduate schools. They are not very precise in arguing for how graduate schools really make a difference, but there is no doubt that the structure in itself is seen as very positive. There is reason to believe that this segment of universities/schools ("fakulteter") actively pursue graduate schools as a remedy for improving and developing research education in their own fields.

2. The lukewarm, but well-adjusted institutions

“... It is a general perception that this graduate school is well functioning and has contributed to support the students in relation to their projects...”

“The graduate school has turned out to be an effective means to develop new, specialised PhD courses of high quality...”

This group does not signal strong enthusiasm, but considers the graduate school as a useful way to organise PhD education. They also seem to be perfectly comfortable with the adjustment to the current educational policy and had accordingly altered local activity in the desired direction. On the other hand, this group is rather imprecise about the graduate school's potential for development and innovation in PhD education.

3. The indifferent and passive followers

“Graduate schools, networks and centres are all means that will support the development and improvement of the PhD education.”

“The graduate schools, networks and centres participate in supporting the PhD education.”

In this group, it is hard to find much enthusiasm for the graduate schools. Most of these self-evaluations signal a passive adjustment to a policy decision and the responses show few elements of dynamic and active engagement in order to figure out how a graduate school really can make a difference regarding improvement and development of PhD education.

It is striking that only one of the self-evaluations was critical. This is remarkable for representatives of a knowledge generating system that is expected to encompass analytical training and an organised scepticism. The critique that this one self-evaluation raises reflects how funds for stipends should be distributed. Attention is also paid to how graduate schools might create asymmetries because they lead to concentration of resources on research agendas that in a larger perspective are dysfunctional.

All of the self-evaluations indicated that the graduate school is understood as a structure for organising PhD education at the local institutional level. It is also clear from the 2005 study (commissioned by the Coordination Board for Research) that international and national cooperation and, subsequently, the creation of larger intellectual environments, had taken place in most of the evaluated graduate schools. Thus, it is probably reasonable to consider the “graduate

school” as a successful innovation seen from the institutional side. However, from a perspective of continued innovation capability and developing a PhD education that is highly regarded internationally, it has potential for great improvement.

The graduate school is certainly a significant step in the right direction. That graduate schools pay significant attention to leadership, organisational and social arrangements, and devote awareness to pedagogical issues is seen as very promising for continued development. A graduate school with its strong focus on uniting national resources and seeking international collaboration is a promising road for a small country. It enables the concentration of resources intertwined with freedom to be innovative.

Recommendation:

- Organise increasing portions of PhD education as “graduate schools” and develop this Danish innovation to become the trademark that can sustain and improve the international recognition of PhD education in Denmark.

The general development of the Danish PhD education

It is of little doubt that the introduction of graduate schools has been a very important tool for changing the PhD landscape in Denmark. The old-fashioned PhD training, where the PhD students followed an individual track and mostly relied on one single advisor, has been substituted with a planned, organised learning landscape. The organisational construction of the “graduate school” focuses on creating a peer-student learning setting, integrating national resources, and creating new working relationships between universities and the broader society. This represents movement in a very promising direction. A secondary effect can be seen in the creation of trans- or multidisciplinary.

From an international perspective, this is certainly cutting-edge development in higher education. The report from the PhD evaluation commissioned in 2000 had the very striking title *A good start*. The title characterised the situation very precisely. Whether this good beginning results in a strengthened PhD education in Denmark will depend on the ability to develop this model further. The idea that a small country with limited economic and human resources could compete with elite universities in the US is illusory, if the goal is to copy these universities in full scale. As an illustration, the endowment (funding basis) for Harvard University is DKK 150 billion and every US academic has his/her travel bag already packed if he or she ever should receive an offer to teach at Harvard. Danish PhD education has to seek its competitive edge in arenas other than playing in

the field of elite US and British universities. The real challenge accordingly will be how to enable a dynamic and developmentally oriented PhD system of world class that can offer opportunities that cannot be created in the segmented and hierarchical US and British educational system.

Graduate schools have another very important feature: they are well suited to cope with the transition of the PhD that we described in Chapter 2. The graduate school gives a broader and thus more flexible education than does the traditional, discipline-based training that occurs in an isolated departmental setting. This has been a major feature of European doctoral education. In many countries there are reports of a growing disjunction between the traditional purpose and the actual use of the Doctorate. This is natural as more and more doctoral degree holders leave academe and seek work elsewhere. The problems tend to be linked to a growing concern about the high level of specialisation and the limited number of skills of the traditional PhD graduate. Doctoral studies are considered to be too narrow or even increasingly irrelevant for a rapidly changing job market.¹⁰ The graduate school is better equipped to prepare students for a broader range of career opportunities, and it could also make that particular kind of preparation into a special comparative advantage and develop it in form and content.¹¹

In the self-evaluation, we raised the question "How does the institution judge the possibilities for further developing the PhD education given the current legislation and funding system?". The general picture of the responses is that the current system is flexible enough to facilitate experimentation and developmental activities. Obstacles in the current funding system are pointed out but not seen as major constraints for development. A reasonable conclusion is that it will be up to the institutions to create enough momentum to take the graduate schools to the next stage. It is evident that there are large differences between graduate schools. In some locations there are very successful innovations while other graduate schools have turned into experiments that did not lead to their desired outcome. All of these experiences are equally important and valuable from the perspective of development and innovation. It would be very beneficial for the continued development of the Danish PhD system to enable a cross-institutional learning system, where experiences from current graduate schools could be shared. Building a national learning system for improvement of PhD education would be one of the most promising roads that could keep the Danish PhD education at the international cutting edge.

¹⁰ *Doctoral Studies and Qualifications in Europe and the United States: Status and Prospects*, ed. Jan Sadlak (Bucharest: UNESCO, 2004), p. 296.

¹¹ *The Responsive Ph.D.: Innovations in U.S. Doctoral Education*, The Woodrow Wilson National Fellowship Foundation, September 2005.

Recommendation:

- Create a dynamic learning society that incorporates all graduate schools and ensures that the schools take on the responsibility for innovation and development. This should lead to a coordinated national effort in making PhD education a learning system.

5. Structure and Organisation

As was made clear in the previous chapter, the panel advocates a gradual move towards a higher density of fully fledged graduate schools in Danish universities. Unless this is prescribed through central decision making, which is a drastic move that we do not advocate (for reasons that will be given), graduate schools in Denmark will be established in a process that is likely to take several years and will progress more rapidly in some universities than in others. Some universities may not even find it useful or appropriate to establish any graduate schools at all. In particular, smaller universities or faculties with very limited resources or a narrow range of disciplines will probably be better off avoiding the demanding graduate school concept and continuing to organise PhD training in departments/disciplines and programmes.

For this specific reason, issues of structure and organisation are important to discuss for Danish PhD education as if there had been no graduate schools at all. Regardless of organisational form, there are always certain key issues concerning admission, supervision, quality control, programme structure (coursework, research, teaching duties), funding, publishing, and career structure that must be addressed. These issues are discussed below. It should be stated that several, if not all, structures and principles are as valid under a small-scale discipline-based graduate training as within a graduate school.

Admission - competitive and international

At present, no general rules exist for the admission of PhD students to the Danish universities. The self-evaluations indicate that the procedure varies a lot from institution to institution and often also from faculty to faculty. It was not clear from the self-evaluations that we have received from the faculties whether the rules they describe apply to all available PhD positions (i.e., positions financed from external research grants allocated to a specific scientist) or only to the so-called faculty stipends. In any case, the picture is quite varied: sometimes the decision is taken by a graduate school commission, sometimes the decision is made at the faculty level, and in some cases it occurs effectively at the department/institute level. Some institutions have fixed admission dates, some do not.

There was a worrying tendency in some cases that the faculty stipends were distributed evenly among the institutes, disregarding quality. The faculty of the humanities at the University of

Copenhagen surprised the panel by saying that they had so few stipends and so many applicants that they simply pre-distributed one stipend to each of the departments. The diffuse processes could easily reduce competition and mobility, and favour local candidates. At the Danish University of Technology a different method was applied. First, there was an open competition between all applicants for faculty stipends (core funding). Then there was a more protracted process through which other stipends – from the EU, research council programmes, etc. – were distributed. In that process, local candidates were often more successful; they were at hand when they were needed and the decisions were pragmatic, taken ad hoc by the Dean of the graduate programme on the advice of the holder of the grant.

Consequently, at DTU the proportion of admitted students from DTU itself, as well as from other universities in Denmark, is a few percent higher than the proportion of all applicants, while the proportion of admitted foreign students is correspondingly lower. There is no reason to believe that DTU stands out in this respect; the panel has been presented with similar descriptions at other universities as well, if not with explicit figures. Aalborg University reports for example that whereas 60% of the applicants to their PhD programme are international students these students make up only 30% of the enrolled, a stunning difference (although it should be noted that the ratio of international/national among enrolled students in Aalborg has increased since 1993, particularly in the last few years). However, the panel has also encountered milieus where routines and admission procedures have been undertaken that disfavour foreign applicants. Thus, it is to some extent a matter of attitude and willingness.

Uncertainty of funding and timetables combined with lax procedures fosters nepotism. In particular, it is disadvantageous to potential foreign applicants who simply can not “be around” in Denmark in the hopes of a random call. This is not fair and not appropriate. To strengthen a healthy and dynamic research environment, the institutes should actively compete for the students, and the students should compete for the places. Graduate education for world class research should engender the broadest representation of meritocracy; nepotism and isolation are the enemies of quality. The lack of clear rules and suitable online documentation (in particular the frequent lack of English documentation) for several faculties/universities is not encouraging for mobility within and across the Danish borders. The self-evaluations show that the percentage of foreign students is almost zero for some faculties (it is highest in technology); the national average across faculties stands at 12%. At all universities there is a significantly lower admission rate among foreign applicants. At Aalborg University, a Danish student is three times as likely to be accepted as is a foreign student.

While admission of foreign students can never be a goal in itself (any student must be well qualified regardless of nationality), the amount of foreign applicants is at least an indication of the visibility/attractiveness of the offered education and the institution at hand. It is the hallmark of quality, and has been since the beginning of modern research education in 19th century Germany. The top research universities in the US reached a very high level of enrolment of foreign PhD students at an early stage, and in general the US research universities have had large proportions of foreign PhD students at least since the 1990s. Enrolment of foreign students is significantly lower in other PhD- and Master's degree granting institutions.¹²

We would suggest that the general level of admission to Danish PhD education be increased to including around a 25% average of foreign students. The right time to do this is of course now, when funding is increasing. In fact, the PhD contracts that we will propose (see chapter 6) should be specific concerning how the university conducts its admission procedures and which goals it sets in relation to foreign students.¹³ Many of these weaknesses could be easily remedied. A commendable admission procedure is already in operation at the The Royal Veterinary and Agricultural University (KVL). At KVL, stipends were distributed to the different units according to a merit system, based on previous performance. These and other examples of good practice should be taken into consideration as PhD admissions are now bound to change and become more formal.

The panel recommends the implementation of a general procedure for the admission of PhD students as follows. First, the universities should introduce fixed admission dates (in line with most of the world's top academic institutions). Two annual admission dates for the whole university is suggested, with the possibility of online applications. All application forms, announcements and relevant documents must be available online, and also in English. The applications should be evaluated at the graduate school level, or faculty level, by a panel that includes representatives from at least two foreign academic institutions. It is recommended that as many as possible of all available positions, not only the faculty positions, are distributed by this panel.

It is recommended, furthermore, that a list of evaluation criteria be published. The "KVL-model" for faculty stipends is recommended as an inspiration, with clear and publicly announced criteria

¹² Syverson, P. D., & Bagley, L. R. (1997). "Graduate enrolment and degrees: 1986 to 1997." Washington, DC: Council of Graduate Schools and Graduate Examinations Board. Table 1.3.

¹³ The panel is aware that if non-EU students are paying fees for their graduate training, this may affect their willingness to apply. In fact, the reasonably high application rates in some, particularly the technological, universities could be explained by the fact that Denmark is a country with no or low fees. There also seems to be a tendency, reported for example at Aalborg University, for foreign students (Germans were mentioned), who already have published articles, to apply to the PhD programme in order to receive a PhD, while Aalborg acquires another PhD at small cost. Under the stricter admission procedure that we propose, this would be impossible.

(credit for high grades, previous research experience etc.); transparency is key. Following the notion that the faculty stipends should attract the “best and the brightest”, prospective students should be encouraged to formulate PhD proposals for these stipends. In parallel, the students can indicate that they wish to be taken into consideration for an externally funded PhD, where usually the project will already have been formulated. These projects should also be published online so that external students can tailor their applications accordingly.

Combining competitive admissions and the 4+4 model

The panel is aware that for some externally funded PhDs, the fixed admission dates may be a problem. Some projects, for different reasons, may have to be started between admission dates. Practical solutions to that problem are, however, easy to come by. For example, at general admissions, a ranking could be made that contains surplus candidates and additional PhD students could be admitted from that list only, and only above a certain level. This system is already applied in some Swedish universities where full funding of PhD students has been a requirement since 1998.

It must also be clarified with the primary Danish funding bodies that they acknowledge this application system. This should pose no problem, we believe. Indeed, we foresee funding agencies supporting it proactively in order to enhance the efficient use of their funds and to make sure they support the best PhD training and -research possible. The panel is also aware that the fixed admission dates might cause a slight delay for some students as to when they can start their PhD studies, but it is firmly believed that a transparent process as described above is a necessary step for bringing the admissions procedures to an international level ensuring fairness and encouraging quality enhancement. It is also customary procedure in all top-notch graduate schools.

One particular note regards the 4+4 model, which mainly is used at the University of Aarhus. The evaluation panel recognises this model as well-functioning. Indeed, the University of Aarhus hosts some of the best graduate schools in the country – and were clearly among the best of those that we had the opportunity to visit – and it has excellent ratings in international league tables in many fields. While the latter phenomenon obviously has many explanations, one factor explaining the success of Aarhus’ PhD education is apparently the more generous time it provides for research and for “testing” more PhD candidates in the “transitory zone” between candidate exam and the PhD programme. Furthermore, a consistent feature in self-evaluations and in our conversations with faculty and students is that the time available for the PhD dissertation is the most critical problem when it comes to maintaining and improving the quality of the PhD, and also to make it

internationally competitive. It seems obvious that this is a point that should be seriously addressed and where the 4+4 model provides interesting opportunities.

However, the 4+4 model has some complicating features with respect to admissions and also in general to the Bologna process. More than the 5+3 model, it tends to favour internal PhD candidates. What is interesting, however, is that while the University of Aarhus in general has a fairly moderate ratio of internally recruited students, its graduate schools boast a strong presence of foreign students, and the graduate schools we visited had very ambitious social programmes to cater to foreign students, a feature that was clearly not always the case at other universities.

The Aarhus experience is important. It demonstrates that the tension between a more extended graduate school and competitive admissions can be overcome. In fact, graduate schools in the US include master's education; i.e., they contain all (post)graduate education. In the UK, a similar system exists in the best universities. At Cambridge, Oxford and St Andrews, but also in more specialised schools such as the Royal College of Art in London, students are recruited worldwide for a postgraduate training that starts with a one-year Master's of Philosophy, after which there is a renewed application for the three year PhD programme, to which candidates can also apply independently; i.e., a 1+3 model

The reason that we note the UK structure in this context is that it seems to suggest that there is a way of organising a four-year graduate school that bridges master's and PhD training as it is understood in the Bologna process, to which Denmark is associated. It is clearly beyond our commission to go deeper into this issue, but it seems inevitable that it be dealt with in the context of an expanding PhD education. While we do believe that both models, 5+3 and 4+4, should be viable, it seems clear to us that the best conditions for a successful PhD training would be achieved if the Aarhus 4+4 model could somehow be combined with the competitive admissions process that we have outlined above, perhaps in a 4+(1+3) model. In essence, it would mean a graduate school at the first stage of which a fairly large number of students entered, and where in particular advanced coursework was undertaken alongside a qualified final thesis (*hovedopgave*). We recommend that this issue be explored further.

Legal and Institutional Framework

The present framework seems generally to work well. Whether decisions concerned with the PhD education are taken on an institutional level or at a *graduate school* level is left to the universities to decide. Where there is a graduate school, however, it should be expected that it is fully responsible; otherwise we would doubt that it is really a graduate school. A slight concern was raised by the

student survey, which showed that a considerable fraction of the student (28%) did not have a fixed project plan after six months. Interestingly, no differences between students attending graduate schools and students not attending graduate schools could be found. The panel recommends that the study plan (*Ph.d.-planen*) be ready at the latest 6 months after commencing the education studies.

The panel sees no reason to change the legal framework (*Bekendtgørelse* nr. 114, 8. March 2002) for the PhD dramatically. A couple of minor changes will be suggested at the end of this section. The responsibility for the PhD education should remain with the universities as is international praxis. This means that the main supervisor (*hovedvejleder*) should normally be appointed at the university institution.

One issue that is a concern is that it is presently possible under special circumstances (*i særlige tilfælde*) for the universities to appoint scientists from so-called government research institutes (*sektorforskningsinstitutioner*) or even private industry to act as a principal supervisor (*hovedvejledere*). The institutions themselves are free to formulate the required regulations.

The panel strongly recommends that the rules for what is required in order to act as external principal supervisor (*ekstern hovedvejleder*) be clarified, in particular so that potential PhD supervisors from government research institutes, other research institutes or industry must undergo a critical evaluation as is indeed already the rule in several places (i.e., every five years by an international panel). A person without qualifications at the PhD level should not be allowed under any circumstances to act as a principal supervisor (*hovedvejleder*) (even if he/she has permanent employment at the university).¹⁴ Furthermore, it is recommended that non-permanent staff such as assistant professors (*adjunkter*) and postgraduate fellows can act as project supervisor (*projektvejleder*) as well as assistant supervisor (*medvejledere*). This is an important step for the development and involvement of young scientific staff and opens up possibilities for connecting PhD students with all research projects in a given research environment.

Presently, it is possible under certain circumstances to receive a PhD without having followed the proper PhD education. The panel recommends that this should no longer be possible. It is not good for transparency and is not in line with customary procedure at the world's best institutions.

Finally it is suggested to introduce a remark concerning the PhD thesis. This is discussed in the section "Thesis and Thesis Evaluation", a few paragraphs below.

¹⁴ The panel is aware that this for some time may still pose a generational problem, since a large part of the 50+ supervisors only have the old master's (*magister*) degree, which, however, used to count as a PhD in international comparison.

Mobility

The self-evaluations as well as the student survey almost unanimously see the required six-month stay abroad as a positive and important part of PhD studies. It is recommended that these rules be maintained as they are, including the possibilities for exemptions when necessary.

The panel wishes to underline that mobility also includes active recruitment of foreign PhD students for admission and for shorter visits, as discussed above. It is the sum total of international experience and professional networks that makes the difference and prepares students for a successful research career. It must be repeated that by international standards, the Danish level of foreign enrolment of PhD students is on the lower side and should be increased.

Thesis and Thesis Evaluation

Presently, it is possible to obtain a PhD degree without having any publications in international peer-reviewed journals, though the self-evaluations indicate that it is common to publish at least one paper during the PhD education. While the panel acknowledges that there might be PhD theses for which a collection of papers is not the best way to present the material – for example in the humanities and the social sciences, where monographs in Danish could be justified – it is strongly recommended that PhD candidates should have submitted at least one manuscript to a peer-reviewed journal by the stage of graduation. It is an indispensable element of the PhD education to learn the process of publication, from designing the paper to writing it up, considering suitable journals, and going through the process of submitting, reviewing, revising proofs, etc.

Even for those whose main work is a monograph in Danish on Danish material, this procedure is crucial to learn, and by putting it on the PhD agenda as a compulsory item, it will also help internationalise those research environments where inward looking tendencies still prevail. The panel has experienced examples of extreme resistance to international presence – like not employing foreign faculty with the baffling argument that they do not know “Danish culture” and are more likely to move away – which has convinced us that all possible means should be sought to safeguard against such short-sightedness.

It is a declared goal that the PhD education in Denmark must be held to high international standards. The panel therefore recommends that the evaluation committee has at least one member from a research institution abroad. Exceptions to this rule should require special permission from the Rector. This recommendation applies to all PhD studies, including all subjects in the

humanities. The panel sees no reason to change the rule that the PhD supervisor is not allowed to be a member of the evaluation panel.

A PhD thesis must be a publicly available document. It is recommended that PhD theses always be assigned ISBN numbers. It is further recommended that the university library should be legally obliged to keep copies of any PhD thesis accepted at the university (no doubt this is already almost unanimously the case). For reasons of intellectual property protection, a PhD may be kept “unpublished” for a certain period. This should also be legally determined. The recommended maximum period is one year.

Other aspects of the PhD education

The PhD education is supposed to be broad and diverse. It is designed to give experience with teaching, dissemination of knowledge, project management, including the economics of a project. It is also supposed to introduce the student into the international networks of the scientific community and other advanced professional networks. This also happens. It is undisputable that the level of internationalisation among Danish PhD students has increased and that most of them are given the opportunity to teach. However, the degree to which these positive features are available to students varies considerably, and they seem to vary by and large along the same lines as other quality indicators. Strong research environments have good networks and can easily facilitate visits abroad and can pave the way for postgraduate research. We have found examples where less than 10% of the students spend more than three months abroad.¹⁵ At the other end of the scale there are research schools where the corresponding figure is 75%; the average stands at just over 50% as was reported above, a figure that should be increased.

Another concern is that although teaching and dissemination is part of the training, it is not part of the evaluation. Although the panel wants to underscore that the PhD dissertation is and should remain the central feature and quality indicator of the PhD education, it is reasonable that the other aspects of the training also be considered. The teaching and dissemination part of the education programme – including experience with project management and with relevant pedagogical tools – should be documented and evaluated as part of the PhD training.

¹⁵ <http://auaw2.aua.auc.dk/fak-tekn/phd/aarsberetning2004.doc>

Productivity and Dropouts

Danish PhD education could be more efficient. The data are deceptive. At face value, productivity seems persistently high by international standards and stays on a fairly stable level. The average time of study in Denmark is slightly more than four years with minimal variations between faculty areas; typically in most countries, the PhD requires five years or more. This is, however, more than a year over the stipulated time of study; indeed a full 40% extra in the worst hit faculties. The overdrafts show no tendency of going down, if anything they have increased somewhat since 1993. We know too little of the reasons for the delays; the universities do not know either and demonstrate a rather surprising lack of interest in the subject. Part of the reason for the longer study period is almost certainly parental leave, although it has not been possible to clarify this with data existing at present. Internationally, part-time study is often an important factor but this should play a less significant role in the salaried Danish PhD system.

It is strongly recommended that the universities collect more detailed data concerning study time and parental leave during the PhD study in the future so that the situation can be monitored properly. It is furthermore recommended that extremely exceeding the study time could lead to sanctions in the financing of future PhD students. This should be a simple and non-bureaucratic procedure. Cambridge, for example, applies a simple and transparent system: for each year of undue delay (parental leave and documented illness are of course due reasons) one stipend the following year is removed from university funding to the particular department or college. Study times should be recorded and reported properly and results be weighed into future funding as one of several success criteria.

The dropout rates are another aspect of efficiency. These students in a sense never finish, and let us recall that average times of study are counted based on those who *do* finish. They are also often very demanding and time consuming before they drop out. Further, they represent, by definition, the deficiencies of the admission procedures. We have asked questions and collected statistics on dropouts (Appendix 6) and they have been discussed in the self-evaluations. Like so many other aspects, figures vary between faculties. Science and agricultural students have the lowest dropout rates, students in the humanities and the social sciences have the highest, and also the longest study times, which thwart statistics somewhat (when is the tardy student to be counted as a dropout?). Definite dropouts in 2004 among 1998 admissions ranged from 3% in the natural sciences (15% if combined with those who had not finished) to a stunning 30% in the humanities (56% if combined with those who had not finished).

There are many reasons for a student to drop out. The possibilities of better paid jobs elsewhere are evident in some areas. The lack of a clear cut career as a PhD graduate is another; this last point clearly does not apply to students in areas such as medicine and technology, where the PhD degree has a distinct extra mural market. But the panel can not avoid the conclusion that considerable and quite problematic elements of the "old" informal doctoral training still linger, despite the new rules of the game, and despite the face lift labelled "graduate schools". We heard very little concern about dropouts, and the faculties of the humanities and the social sciences did not do a whole lot of soul searching on this matter in their self-evaluations. True, we lack the knowledge of real causes and motives behind the statistics. So do the universities. They do not know whether dropouts have anything in common: e.g., sex, nation, social class, university background, previous lines of study. Worse, they have conducted no concerted effort to find out.

This should be a concern. The Ministry of Science, Technology and Innovation and Statistics Denmark should consider better ways of measuring the real study times, taking into account the dropouts. Dropout figures should be more carefully monitored by universities. We also recommend that universities systematically gather information as to why PhD students drop out. This is one of the few points where the Danish PhD education is clearly underperforming, and it does so at the cost of young and gifted people who deserve better. It is a cost for all; if universities could cut the dropout rate by three quarters, Denmark would increase the annual number of degrees by some 25%. That is half the cost of the new PhD funding package - at no cost at all.

Funding schemes for Danish PhD students

There are several different channels for the financing of students seeking Danish PhD degrees and no complete statistics exist. The lack of information is surprising, and so astonishingly scarce that it is not even possible to say exactly how many PhD degrees are bestowed each year. This is true for many funding agencies. The universities, which receive unspecified block grants that also cover PhD training, can not say how much their PhD training costs, not individually, let alone as a collective enterprise; only rough estimates exist.

The research councils, which fund individual projects as well as large programmes, have no exact information on PhD funding either, nor do they claim to have any responsibility for it. Internal allocation of funds in projects and programmes is the prerogative of the research performer, most often universities. The Ministry of Science, Technology and Innovation or the research councils do not collect this type of information. The only funding agency which seems to be in full control of its PhD funding streams is the Industrial PhD secretariat under the Ministry of Science,

Technology and Innovation, which organises training of industrial PhDs. It has perfect overview of its well managed programme, which has also recently undergone a very positive evaluation (2005).¹⁶

Because of these factors, it must be emphasised that it is only possible to provide an estimate of the situation. The numbers shown here are taken from a handout provided by the Ministry for the evaluation panel members (October 2005) as well as from websites.

Furthermore, when discussing the financing of a PhD degree, it is important to distinguish between two different aspects of the funding. There is (1) the basic “cost” of a PhD student, which covers the salary and (2) overhead (*uddannelseskost*) for the research institute to which the student is attached. The nominal overhead that should be “charged” by the research institutions is DKK 132,900 per year for an experimental PhD and DKK 88,500 for a non-experimental PhD (these figures may, however, vary in practice). For several experimentally oriented PhDs in the natural sciences, as well as for some in other disciplines requiring a lot of field work, the nominal sum is not enough to cover the actual expenses. It is important to consider this in the context of a future expansion of the number of PhDs (in particular for the expansion within the natural sciences) or there is a danger that PhD students will not receive adequate training due to lack of resources (equipment, chemicals etc.). The costs of consumables alone for an industrial PhD student at NOVO Nordisk is typically between DKK 50,000 and 200,000 per year, occasionally more.

The basic funding of PhD students can be divided into the following categories – we concentrate here on the individual students and their stipends and salaries, in the next chapter we will analyse the gross funding streams.

I. Faculty Grants (fakultetsstipendier)

This can be considered to be the “classical” funding scheme. Before the change in the university legislation in 1993, a number of PhD positions were allocated to each faculty every year. The universities seem to have largely kept the number of studentships after the reform, which they had before (though it should be emphasised that they are not obliged to do so and could choose to cut down on the numbers and spend this money on other things, including better infrastructure and other resources for PhD training).

Typically these stipends are handed out to “the best and the brightest”, though in several places the competition is not carried out on the faculty level, but only on the institute level in the sense that each institute is allocated a fixed number of stipends every year. It is questionable (as we discussed

¹⁶ *Effect Study of the Danish Industrial PhD Programme*. A Study conducted by Kvistgaard Consult A/S for the Ministry of Science, Technology and Industry (April-June 2005).

in the previous chapter) whether this is the best way of ensuring that the stipends really reach the best people doing the most challenging, frontier-oriented research. An additional problem is that these stipends are being “eaten” by the necessity to match with core funding the external funding for co-financed stipends (*samfinansierede stipendier*) (see below).

The 2000 PhD evaluation indicated that the universities provided the main financing for about 50% of the students. Since the universities did not co-fund stipends back then, presumably all of these were faculty stipends.

II. PhDs financed through individual research grants

These PhD studies are financed through research grants for individual researchers. Typical sources include the research councils (*Det strategiske forskningsråd, Det Frie Forskningsråd*), but also private funds and international sources such as the European Union. The basic research fund (*Grundforskningsfonden*) provided about DKK 33 million per year for PhD stipends, including co-financed stipends (*samfinansierede stipendier*). No data exist on how large a fraction of the sources provided by the research councils is spent on PhD stipends (because PhD students are sometimes non-specified parts of large grants to universities), although we do know that the number of individual stipends payed by the research councils is around 100 (2005).

III. Stipends in cooperation with industry/external research institutions

Co-financed stipends (samfinansierede stipendier)

This is a model which has existed since 1988. As the name implies the funding is provided through several channels. In the 1990's the funding was shared between a university and primarily an other public research institution (typically a public sector institution (*sektorforskningsinstitution*), a hospital or, to a smaller extent, for example a museum or a library) and the former Danish Research Academy (*Forskerakademiet*). With the advent of the research schools from around 2000 the funding pattern changed. Since then normally the university supplies one third, one third is supplied through industry (one or more companies) or a larger independent research organisation, and one third is provided directly by the state through the Danish Research Coordination Committee (*Koordinationsudvalget for forskning, KUF*), i.e. handled by the Danish Research Training Committee (*Forskeruddannelsesudvalget, FUU*). In order to receive a co-financed stipend from this Committee it is a requirement to be attached to a graduate school. Only quite few stipends have been funded this way, although starting in 2005 additional funding has been given to allow for more than 200 co-financed stipends to be opened.

ErhvervsPhD (Industrial PhD)

These PhDs are financed between 60 and 70% by an industrial partner and to 30-40% directly by the state through an evaluation panel with prominent members from the Danish industry and research institutions. The student is an employee of the industrial partner and all intellectual property automatically belongs to the company, though some kind of additional compensational agreement may be made. The sum allocated to the programme is about DKK 51 million per Year, corresponding to about 70 PhDs.

Research Projects

It is possible for a company to make a research agreement with a university and thus fund a PhD student directly or indirectly. There are some puzzling taxation issues here. Money spent on research can be tax deductible with 150%. This also applies to co-financed stipends (*samfinansierede stipendier*), which therefore are quite cheap, seen from the point of view of the firm. It does not, however, apply to Industrial PhDs (*ErhvervsPhD-ordringen*), for which the cost is picked up directly by the Industrial PhD Secretariat under the Ministry, i.e., by public funds.

Privately Funded PhDs

A very limited number of students finance their own PhD studies. In this context, it is particularly interesting to determine if one should be allowed to have work evaluated for a PhD against payment. This would typically mean that you can have done research work for a number of years in industry. This work you then hand in for evaluation at a university against payment. If the work is considered of a high enough standard, you are provided with a PhD degree from the institution without having ever played an active part in the research environment of said institution. Aalborg University indicated that they might be interested in such a scheme.

The panel, however, is quite sceptical. The PhD is an exam that is supposed to be the final result of a comprehensive programme of study and research. It is essential, if the overarching goals of Danish PhD education should be reached, that the student is accepted to this programme in competition and that the full course of study is taken by the student in the context of a research environment of high quality. The reasonable conclusion is that privately funded PhDs should be abolished. The argument here is not about money but about the quality of the education. If a student is on the list of possible admissions - above the line - and can satisfyingly demonstrate personal funds to cover the education and is also willing to provide regular university overhead fees, there could be no argument against that candidate being admitted, although we assume the cases are few.

Summary of recommendations:

- The panel recommends changing the admission procedure for PhD students in Denmark to bring it in line with international standards. A procedure with fixed admission dates (once or twice annually) and transparent evaluation criteria is suggested.
- The panel recommends that there should always be a person from a foreign research institution on PhD evaluation committees. Exemption from this rule should only be allowed with special permission from the Rector.
- The PhD thesis must be publicly available (as a minimum equipped with an ISBN nr. and available in the university library) at the latest one year after the examination.
- Assistant professors (*adjunkter*) and Postgraduate fellows should be allowed to act as "Projekt-" and "Medvejledere".
- The requirements for external "Hovedvejledere" from government research institutes (*sektorforskningsinstitutioner*), the industry and the public sector should be clarified. Under no circumstances should it be possible to act as "Hovedvejleder" without having a PhD.

6. The Implications for Funding

Funding is a powerful tool by which parliament and government can steer the research system. It is certainly not a sufficient tool to achieve all goals in complex matters such as research and, obviously, PhD training, but it is an important tool. The panel believes strongly that a careful review of the funding mechanisms will facilitate the transition that the Danish PhD education is going through and that adjustments are necessary.

Funding, quality and incentives

The current funding sources and funding forms were presented in the previous chapter. We have asked the following questions: Are they adequate and efficient? Are they fair? Do they support the goals of the Danish PhD education as expressed in current legislation? Do they support the wider set of goals that the panel discussed in Chapter 1?

The answers are mixed. It depends on who one asks and regarding what aspect of the funding system. Students – those who are accepted to PhD studies – are generally quite satisfied (Tables 17 and 18). What they tell us is, once you have received funding you are OK. Only a small portion is dissatisfied or critical.¹⁷ When we ask the universities, there is a wider variety of answers. Most universities claim that the full costs for PhD research are not covered, either by core funding or by external funds.

Most answers that we have received concern the size of the funding. Very rarely have we received comments on the principles of funding, despite the almost endlessly repeated claim from universities that they wish to receive the funding as direct funds, i.e., block grants from the government. They say, as does the University of Aarhus, that it will make planning easier and education more efficient. However, an in-depth argument for their position beyond the apparent self interest is largely lacking. Nor have universities provided any clear position on how funding could be structured in order to make it more fair or more apt to support the goals of PhD education, nationally or locally.

¹⁷ They are more critical of other aspects of the PhD training such as the amount of teaching and the haphazard opportunities to go abroad during the PhD training. See also "Considerations on Changing the PhD education" (mimeo), The PhD-net, March 2005.

We do not make this point about the lack of coherent thinking on funding without a reason. In the immediate future, a fifty percent increase of funds will be released to improve and enlarge PhD training, and indications have been made that the increase may be even bigger than that in the years to come. In any case, it is an unprecedented increase of funds. The risks of abuse or sloppiness are apparent. Therefore, it is absolutely essential that these funds be wisely and fairly used. Hence, the need for sound, creative and fair mechanisms that, at the same time, can promote quality through funding incentives, give universities reasonable autonomy and leg room for planning, and allow for reallocation of funds over the long term and thus ensure fairness – rewards to the striving and the good ones, reduction of funds for those who do not use their resources well.

In fact, several universities have already adopted such funding schemes in their own daily practices.

The present system – a critical assessment

The outlines and principles of the funding and incentive system could also be described in a slightly different fashion. We will do this with an eye to the discussion of quality and to a future funding system the principles of which we will outline below. Considering the envisioned massive enlargement of PhD education in Denmark, the issue of funding mechanisms, and the incentives that are built into those mechanisms, will be of greatest importance to secure an efficient use of funds.

In the present system, funds for Danish PhD training are distributed in three principal funding streams. 1) The first funding stream is the regular core funding that is distributed to degree-granting institutions, i.e., the twelve universities. 2) The second stream consists of funds from a range of external sources: research councils, foundations, private firms, EU programmes, etc. A significant source of second stream funding is directed to graduate schools and comes from the Danish Research Coordination Committee, (*Koordinationsudvalget for forskning, KUF*) by its Danish Research Training Committee (*Forskeruddannelsesudvalget, FUU*). 3) The third funding stream is the public funding for Industrial PhD's (*ErhvervsPhD*).

The statistical breakdown of total PhD training funds from these funding streams is not very easy to do however. It may seem surprising, but, as we have already indicated, it is quite difficult to get the full picture of the costs and funding of PhD education in its entirety. In Appendix 2, the main sources of public funding are presented. As can easily be seen in the Appendix, it is virtually impossible to find out what the costs of PhD education in Denmark are. The panel has tried to find out more about this, and received ample assistance from the Ministry of Science, Technology and Innovation, but we have concluded that it is not possible. The remarkable conclusion is that

nobody knows the cost of PhD training in Denmark. This is a fact that is hard to reconcile with the repeated political declarations that it is a highly prioritised policy area.

What we do know, however, is that the first funding stream is by far the largest, with some 60% of the total PhD funds (our approximation), including most of the costs for infrastructure. The second stream is the second largest, if all external funding sources are combined, it covers an estimated one third of the costs. The third is by far the smallest. The total number of industrial PhDs has been on the level of 50 enrolled per year around 2000, but has climbed to 83 in 2005, and is expected to reach 100 in annual enrolment in 2006. In relative terms, this is growth from around 4% of the total national enrolment to around 7% (the exact figure depending on the level of total enrolment); in terms of funding probably somewhat less.¹⁸

In their self-evaluations, the universities tend to look at all funding streams as providing funds for an education of equal quality. In other words, all money for PhD training contributes to a good education from a scientific point of view. The panel does not take issue with this opinion. One conclusion, however, is that there will be considerable freedom in applying funding mechanisms that can meet other ambitions for the PhD training, apart from the scientific one. On the other hand, there has been some criticism, not least from students, vis-à-vis the scheduled time to complete a PhD, and the relatively large portion of that time that is devoted to teaching, third mission, and other duties external to research in the purest sense.

The funding mechanism must primarily function as an incentive to provide PhD education of the highest quality. Today it is questionable whether that is the case. If we look at the first, and the largest, funding stream, we find that there is no direct incentive for the universities and their faculties to allocate money from their core funding to PhD training. Neither quality nor numbers of PhDs is rewarded. In fact, over the short- and middle-term, the only thing that happens if a university puts more of its funds into PhD training is that it will have fewer funds for senior faculty, which should perhaps rather be seen as a counter incentive.

The second, competitive, funding stream provides no direct incentive either, nor does the third. However, there is an indirect relation between the three. A university is perfectly free to prioritise

¹⁸ We would like to underline that when we, as in this case, compare costs between different funding streams we refer to total costs, including both the cost of the stipend to the student (including overheads) and other costs such as equipment, instruments, field trips, periods abroad etcetera. As we have already indicated these costs are, unfortunately, not known exactly across the Danish system of PhD education. We have had to make estimates. Enrolment figures are much easier to know exactly. When, for example, we present figures of enrolment of Industrial PhD's (as above), it does not follow that the funding of those through stipends make up the entire costs of their PhD training. There are always local costs at the university or department level that are not covered by the stipends and they have to be taken into account when financial comparisons are made. With the present data this is not possible, and it would be a great advantage if the financial transparency of the Danish PhD education was improved.

its PhD training through internal reallocation and thus enhance chances of gaining grants from streams two and three. But, in reality, chances are slim since competitive funds are allocated to new PhD *students*, not to the PhD *graduates*. One way of dealing with this problem might be to include a postdoctoral package in the general expansion of PhD education.

The present system in fact discourages internal reallocation of funds to PhD training. It is in fact rational *not* to use faculty resources on PhD training. Generous funds to senior faculty increase chances of external income to the university much more than do allocations for PhD students. Firstly, because the senior researchers' likelihood of staying on the faculty vastly exceeds the likelihood of a new PhD staying on after her/his degree is granted. Secondly, because there is much more competitive funding available for senior and mid-career faculty than there is for PhD students. The large majority of all competitive funding through research councils and the Danish National Advanced Technology Foundation (*Højteknologifonden*) is directed towards researchers who already have a PhD degree.

An important feature of the new PhD is time. As has been discussed above, the goal is three years of full-time study for the PhD, but the average is close to four years and in some faculties a sizeable fraction of the students use much more time than that. Some simply drop out or never finish; the national average across all faculties is probably 25-30%, although we lack exact figures. There is little, if any, incentive in the present system to work towards meeting the time goal. The funding is provided before the programme starts; there is no immediate economic reward for the student in finishing, or for the faculty member to make her/him finish. Losing a student, or keeping a student, means no loss of funds.

With competitive funding, the situation is slightly different. If a faculty, or a graduate school, fails to confer an adequate number of PhD degrees corresponding reasonably with their level of funding, the funding agency can take that inadequacy into consideration for the next funding period, just like an individual scientist always builds on her/his reputation. But this of course requires that the funding agency knows to what extent it funds PhD students.

It seems obvious, against this background, that all funding for PhD training should become visible and accountable. Funding streams 2 and 3 are already visible and accountable. Should funding stream 1 be separated from core faculty funding and be made into a separate, accountable part of university funding? Or, should all increases in the funding of PhD training be funnelled through funding streams 2 and 3, thus diminishing the share of PhD training which is at the free disposal of universities? One may indeed ask, should funding stream 1 be kept at all?

These questions are tightly interwoven with the issue of goals for PhD training in very general terms. If heavy emphasis was to be put on industrial relevance, it seems reasonable, as one funding instrument, to increase direct funding of the programme for industrial PhDs through the National Council for Technology and Innovation (*Rådet for Teknologi og Innovation*) (funding stream 3). One could also earmark funds that are diverted through research councils or the Danish Research Training Committee (*Forskeruddannelsesudvalget, FUU*) to secure their use for funding of so-called co-financed stipends (*samfinansierede stipendier*). Then core funding need not be used for matching those funds.

If, on the other hand, an important goal is general support for basic science training, and for basic science as well, then the question is whether this funding should be sent directly to the faculties or through an intermediary such as the Danish Research Training Committee (*Forskeruddannelsesudvalget, FUU*), or a research council.

Yet another issue is who should decide on the sectorial allocation, i.e., which academic faculty gets which portion of PhD training funds. At present, there are no top down decisions on which shares should be spent on medicine, science, the humanities, etc. Nor is there, to our knowledge, any mechanism to assess what proportions would serve Denmark well, or why. So far, it has been the prerogative of the universities to decide what kind of PhD students they wish to educate. The results are quite balanced between sectors, as can be seen from the tables in Appendix 7. From the Appendix, it is also evident that the Nordic countries differ quite substantially in this regard. The PhD production according to sectors in Sweden and Denmark is seen in the figure below.

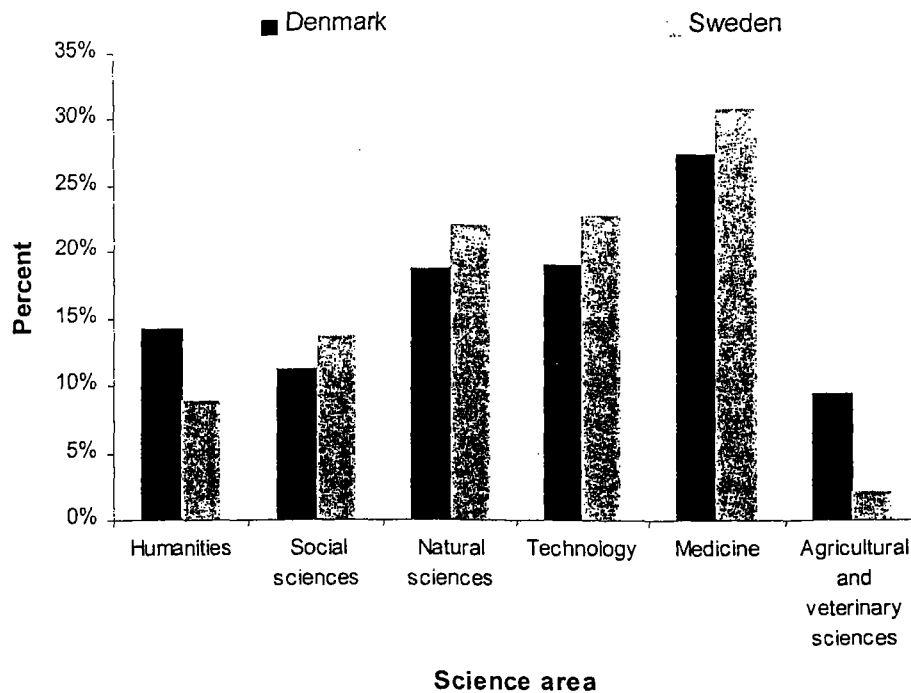


Figure 4. Share of total number of PhD degrees per science area 2004. Source: Norbal.

When presented in this way, it is quite clear that in an expanded PhD training system, the issues of priorities and balancing become critical. The very balanced distribution among faculties in Denmark may or may not correspond to societal needs. The panel, for example, has noted a strong interest in more, and more applied, PhD training for commerce, trade and business. There has also been a demand on medicine and applied social sciences (*Det innovative humaniora og samfundsvidenskab*, August 2005). Internationally, the experience is that there is constant change going on. In the US, as in many countries, the life sciences have taken an ever growing proportion of PhD enrolment, and degrees in reasonably new areas such as design, media, and the arts have soared. In the future, yet other kinds of PhDs may be highest in demand. How should that be dealt with in a small national system?

As for resource allocation between sectors, our impression is that past allocations are the primary deciding factor when new funds arrive. If massive new funding comes in the next few years, it seems reasonable to question the existing order, since, if it is kept, it will be very hard to change later.

There is yet another dimension to this issue. Increasingly, graduate training is organised in graduate schools. Some of those schools are very good, others are of more dubious quality. The same could obviously be said about training in traditional disciplines and institutions. Should it be an issue of the parliament, when it allocates funds for graduate training, to have an opinion on the organisational form of the training? In some countries this is the case. In Sweden, new funding for graduate training in recent years has been earmarked for a range of graduate schools. These have been organised as networks involving several universities and colleges. It has, at the same time, been a way of organising graduate work for students who are enrolled in universities that lack the right to grant the PhD, i.e., a way of decentralising academic potentials without having to inflate degree granting rights. But the argument, of course, has been that graduate schools improve quality, although nobody really knows whether that is the case – networking graduate schools really have no precedents.

The incentive/funding issue easily turns into a complex nexus of quite difficult questions. A single “rational” best decision will be very hard to find. In practice, the opinion on the issue will probably depend on who is asked. Universities have already told us, not unexpectedly, that they regard increased core funding as a good model. Those involved in industrial PhDs argue that increased funding of those is a good idea. Presumably, the research councils believe that they are best equipped to do the job, although research councils (largely populated by university representatives as they are) often side with universities as well.

The demand we should put on the system that we advocate – preferably based on a transparent assessment of the pros and cons of the present system – is at least that it should provide incentives to actors on all levels: the student, the faculty/university, the funding agency, and the cooperating firm/organisation.

An idea would be to create a new funding system for PhD training as part and parcel of the apparent major increase in PhD education. The panel has considered in particular an enlarged role for the Danish Research Training Committee (*Forskeruddannelsesudvalget, FUU*). One could also install an assessment/revision mechanism that provides council to government and parliament on the overriding decision concerning funding proportions allocated between sectorial shares of industrial PhDs. If graduate training was made competitive, there would have to be mechanisms installed to measure quality in terms of both qualitative (assessments, publishing data, other indicators) and quantitative (output, numbers of degrees) indicators in order for the funding agency to redistribute funds. There is clearly an advantage to the general flexibility of the present market system and what we have in mind is certainly not a return to a rigid man-power planning,

transcended in a new incarnation on the PhD level. But, on the other hand, a radically enlarged system without some sort of monitoring concerning whether the main emphasis of training is in line with the main emphasis of demand should be part of the improved knowledge and "self understanding" of PhD education that Denmark needs.

To get started – principles and criteria

To get the new system started, there will have to be some initial distribution of funds according, at least, to capacity. In order to make competition fair, it seems reasonable, however, to distribute new funds over several years so as to make it possible for all schools to adjust to the new circumstances. If a system of this kind is introduced, a closer look will have to be taken at the existing funds, in particular funding stream 1. Since those funds, by definition, are not earmarked, it may take some skill in making them available for a new system. An alternative would be just to leave them as they are, but it is obvious that because these funds are not accountable, this course of action could be risky.

An alternative model would be to distribute funds through the universities, measure performance in them and redistribute funds accordingly. In both cases, the practical forms, in principle, could be decentralised to the university or faculty.

Through these incentives, the universities are likely to develop the kind of research training that best fulfils the quality criteria. The crucial challenge is to define criteria. Should there be criteria for third mission? Should there be criteria for the tacit skills demanded by industry? Should there be different criteria for different funding streams? Could, for example, increased special funding for industrial PhDs be seen as part of the innovation system and operate under different success criteria than the traditional research training that is primarily part of the academic system? Or should universal success criteria apply? What about differential criteria between sectors? To what extent should there be special criteria to safeguard the special character of the humanities and the social sciences? Is there, for example, a risk that the research base of things "Danish" erodes if universal performance criteria, modelled on the hegemonic natural sciences, are applied to these sectors, pushing historians, geographers, sociologists etc. away from domestic issues to look for more internationally publishable topics?

A funding scheme for the future

Against the background of these questions and deliberations, we would like to propose below some general guidelines for a reviewed funding system. The demands that should be put on this system have been presented directly and indirectly in the discussion over the previous several pages. The

bottom line is that it should give incentives for quality and quantity in the production of PhD graduates, incentives that are sustainable over the long term and provide fair and transparent rules of the game for students, faculty, universities, industry and other sectors of society, and for all funding agencies.

One basic guiding principle should be stated first: there should be liberty of form. Universities should be free to organise their graduate training in the form they see fit. This is an important dimension of academic freedom. It is also hard to see that anyone else would know better than the universities how the training should be conducted. The role of the state, who in a sense serves as the client, or commissioner of PhDs, towards the universities, is to put such funding and other mechanisms in place so as to make sure that the goals of training are met, and, if need be, this brings about the structure that serves the purpose, and in right the right proportion.

Conversely, the universities should be open about their goals and ambitions. They should also be prepared to report back on the results of PhD programmes.

We envision this process of mutual information and understanding to take the form of reasonably long term agreements, PhD contracts (*ph.d.-kontrakter*). The PhD contract should be agreed upon between the individual university and the state through the Ministry of Science, Technology and Innovation. We will elaborate on this below.

A second guiding principle is based on the fact that only universities award PhDs, and therefore they are entitled to receive core funding for research training, a funding that they, however, could bestow on partners in research training. It is indeed already the case that universities cooperate with institutes, firms and organisations in their graduate programmes. That is to be commended, and accordingly, financial solutions should be sought.

Following these two basic principles, we recommend that the division of three principle kinds of funding be maintained: 1) university core grants, 2) competitive funding, and 3) designated funding for industrial PhD training. However, we recommend substantial revisions of funding principles and procedures.

Now, let us explain in some detail how we envision the three funding streams, give the arguments for each funding stream and explain their respective roles towards the good of the whole.

1) *Core funding to universities.*

We recommend that a substantial portion of PhD funding be allocated to university core funding and be made visible as a separate part of the bookkeeping of universities, just as is the case with undergraduate funding. Today's system, where universities are free to choose how much (or how little) of their core funding goes into graduate training, should be abolished. (Indeed, if it was kept it would be almost meaningless to allocate new funds to "PhD education" since the universities could choose to do something else with their new funds.)

Why is core funding a good idea in times when competitive funding is gaining way in virtually all nations and systems? First of all, no competitive system works unless the competitors have funds to get into the game. If Denmark is to continue letting all twelve universities perform their own PhD training – and this system is hard to roll back once it is started – then all graduate schools should stand a fair chance of getting onto a career path. Second, some stability and predictability is necessary with long term activities. Third, and perhaps most importantly, we believe strongly that a large measure of absolute freedom of research is a very healthy dimension of an ambitious and sustainable PhD training programme. PhD candidates should be allowed to take part in ground breaking basic research, and such projects should be able to start within the university on core funds. It is a large measure of the freedom of students and faculty, and it helps provide a research career that is attractive for the most talented young minds, within Denmark or abroad.

The core funding should amount to at least 30% and a maximum of 50% of the total graduate student funding in the country. Some flexibility is needed, since private donors, ad hoc industrial projects, foundation initiatives, etc. will always occur. When such funding sources increase or decrease, which they do all the time, their allocations will affect the proportion of total funding that core funding from the state occupies. We believe a reasonable level to start with is 40%, which is slightly less than circumstances today. If state funded PhD training is increased by 50% (which is implied by The Folketing (*Folketinget*), it still means an increase in absolute terms of the actual direct funding of PhD training over university budgets.

How should core funds be distributed across the system? Fairly – and accountably. Perhaps the hardest part is getting started. To distribute new competitive funding is comparatively easy, and we shall return to that shortly. To distribute new core funding is harder: should you just increase proportionately on present levels of core funding for PhD training – and potentially punish those who have been able to scale that funding down because they have acquired external funding? Or, should you try and find some principle with which to change proportions?

We argue that total spending on PhD training, taken as an average of the period 2000-2005, should be one of two key indicators (weighing at 50% each). Thus, those who have prioritised PhD training and have been able to secure competitive funding will get rewarded for their efforts. The second indicator should be the number of PhD students successfully trained over the same period, i.e., accumulated degrees over the six calendar years. Thus, those who have been efficient in their PhD training programmes – in effect since the 1993 reform – will get rewarded. There will also be some levelling effect between schools that have costly PhD degrees (equipment, laboratories) and those that spend less money on each student and may produce more degrees per DKK.¹⁹

The previous paragraph suggests that new core funding will be distributed fairly. It should also be accountable, in fact all core funding must be. We believe, however, that the flexibility of core funding is to be over the long term. The evaluative indicators must be carefully chosen, but it seems reasonable that the number of PhD degrees awarded as a rolling multi-year annual average (five year averages would probably be about right) could serve as one indicator. Degree production could also be sub-divided by field; Denmark must have PhDs in all areas, but they need not be provided by every university in all areas.²⁰ Other indicators could be bibliometric, to secure that PhD candidates publish articles in good enough journals and in sufficient numbers, and scholarly monographs/books of publishable quality (i.e., published by reputed academic presses within a certain time window after the PhD degree is conferred). Based on these accountability indicators, funds should be redistributed, at around five year intervals.²¹

A crucial instrument in the long-term reallocation of funds will be the PhD contracts. Their primary role should be to enhance quality and make sure that PhD training is a top priority. In drafting them, graduate schools, faculties, and departments should be involved, and certainly the students and external partners and funding agencies. The PhD contract will provide a forum for debate on the direction, forms and priorities for PhD education. It is essential that the contract focuses on quality, which inevitably implies that quantitative indicators of quality should also be identified. The PhD contracts will provide a basic document for the evaluation of PhD training and, thus, for the ongoing reallocation of core funding. For example, each university should be able

¹⁹ If there are schools that have special circumstances, like the College of Teacher Education, a fusion in 2000 of Danmarks Lærerhøjskole with Danmarks Pædagogiske Institut and Danmarks Pædagoghøjskole, which has only recently started its PhD training, special funding quota will have to be designed.

²⁰ This aspect to some extent has to do with academic freedom, or whether universities will be able to allocate their resources to whichever field they want. If that is the case, they should be allowed to specialise according to their independent strategic deliberations. These should be outlined in the PhD contracts and should be accounted for. If the output becomes disproportionate, the state could act through the FUU or by negotiation with universities to secure a balance. A last resort, which we do not recommend, could be to introduce production targets in different faculty areas.

²¹ It is not the remit of the panel to suggest indicators; these should be regarded as examples.

to say, approximately, how many PhDs they intend to train within certain subject areas, which gives the Ministry and government a chance to find out whether basic needs are met. It also provides reasonable instruments for the political level to reallocate resources for PhD training between sectorial areas.

How often should new PhD contracts be agreed? We assume that they follow the same six year cycle as the reallocation of core funding, but with a mid-term follow up that allows for possible adjustments.

It must be emphasised that the level of core funding that we have argued is reasonable, 40%, at a system-wide level. Individual universities will start on different levels, a) because of the proposed distribution mechanism at Time Zero, and b) because of their varying abilities to acquire competitive funds. The latter reason will be far more influential than the former. With time, anything could happen. It is likely, even preferable, that differences will increase between institutions, reflecting differential capabilities in PhD training. However, since core funding and project funding will probably change in parallel, we do not expect the proportions of core funding to oscillate too markedly from 40%.

2) *Competitive funding*

It is absolutely necessary that PhD training be carried out in excellent research environments and in departments and faculties that are attentive to the best of the new methods and theoretical developments. Research develops fast. This means that the system must be capable of reallocating funds reasonably quickly. Competitive funding does just that.

Another strong argument for large portions of competitive funding is that the past should not be allowed to throw too much of its shadow on the future. This funding stream gives opportunities to the new universities and to the small, the odd, the emerging, and the neglected. The same goes for individual departments or faculties. With generous funds available for new proposals, entrepreneurial and ingenious researchers can fairly quickly get support for their ideas, and suddenly be in the midst of thriving environments, which would not be possible under a regime that solely funded graduate training on a par with past years' performance (which is, by and large, what our funding stream 1 does).

We understand that there is a variety of funding agencies, which is a healthy thing. Some competitive situation on the funding side is also healthy, and the researcher likes a choice too. In particular, if a research idea is turned down in one place, then it is possible to go somewhere else to

test it. However, this argument is less valid for the PhD student, who does not normally apply for her or his own funds.

Funding stream 2 should be chiefly funnelled through the Danish Research Training Committee (*Forskeruddannelsesudvalget, FUU*), although research councils, foundations, EU funds, and private sponsors are of course always free to finance PhD candidates, should they decide to do so. We believe that it is reasonable to allow as much as 40 to 50% of the total costs for PhD training to be distributed through FUU; the exact proportion would be dependent on the level of funding from other external sources. The distribution should be flexible and allow a fair amount of freedom to the FUU and rely on its professionalism. However, it should follow the main objectives of a PhD training policy.

This implies some division of the FUU funds. In line with the main thrust of this report, the panel recommends that a large portion of competitive funds be allocated to graduate schools (*forskerskoler*), as they have been defined above (Chapter 4). This is the chief instrument to achieve the kind of major change in PhD training that we find would be good for Denmark. It requires a quite fundamental reassessment of the concept of the graduate school as we have already discussed. The previous allotments, small and manifold, will have to be drastically cut back in numbers and substantially increased in size. It will also be essential for the FUU to look carefully at universities' PhD contracts in order to evaluate their priorities. Matching funds from core funding in order to establish and run graduate schools are necessary. Correctly introduced, this funding mechanism will provide a very healthy arena indeed for long term efforts to enhance quality and international cooperation in PhD training.

FUU should also, in the panel's view, take responsibility for the co-funded stipends (*samfinansierede stipendier*), to the extent that these are needed in tomorrow's funding portfolio. Today, these stipends inflict on the freedom of universities who find that their own PhD priorities are compromised vis-à-vis those of industry. That is not what core funding is for. It would be much better if FUU allotted a designated portion of its funding, which the industry and universities, in cooperation, could apply to for funds to match those of industry. Then FUU could prioritise the best projects in national competition. If industry really needs PhD research beyond what FUU funding can carry, they are free to pay the full costs to make it happen; generous tax deductions apply and will work as an incentive.

A new funding initiative should be introduced to allow for especially talented career PhDs. We have called this the "+100 programme". Its main feature is to allow for a limited number of top PhD

candidates in different subject areas to get funding for their PhD studies plus an additional postgraduate year. About 100 students should at any given time be enrolled in this four year programme, which means an intake of 25 candidates per year. The programme has experimental features. The main idea is that the money solely follows the student, who is accepted on the basis of his/her profile. It is not necessary to have a predefined project or a supervisor or university affiliation at the time of allocation, though supervisor and university must of course have been determined when the payment starts. The student applies directly to FUU. The idea is that this +100 programme apart from funding bright people can serve as a "benchmark" for the universities as to where the students want to go. To insure international mobility, the PhD studies or the postgraduate research (but not both) can be carried out abroad.

The present internationalisation programme from FUU offering international PhD stipends in cooperation with Danish graduate schools should remain as it is. There should also be chances for young researchers to launch their careers through smaller projects involving one or in exceptional cases two PhD students. This possibility could certainly be provided through universities' core funding, but there should be opportunities for those who fall outside local priorities or who want funds in order to move to another university after their degree. In fact, this opportunity has a certain resemblance to the +100 programme, but the funding is focused on the PhD support for postgraduate research or early career project rather than on the PhD candidate.

The FUU should have a mix of members, with a core representing leading academic expertise, but with representatives from industry and the public sector. It should also have a distinct role and must be able to take decisions with authority, which implies that the constitutional relations between the Danish Research Coordination Committee (*Koordinationsudvalget for forskning, KUF*) and the Danish Research Training Committee (*Forskeruddannelsesudvalget, FUU*) need to be re-examined. We also recommend that FUU is reinforced and equipped accordingly, including substantial administrative and expert capabilities for the follow up on quality and performance, a capacity that could also serve as a support mechanism for government in the assessments necessary for funding stream a).

3) *Industrial PhDs (ErhvervsPhD-ordningen)*

We believe strongly that the successful programme for industrial PhDs should continue and expand. It has been evaluated with excellent results and further growth is recommended for a variety of reasons, including diversity, excellence in industrial PhD training, and the potential

impact on society, economic growth, and wealth. Within the next six to eight-year period we propose that the total portion of the third funding stream continues to grow substantially; we recommend considering a doubling on the present level to around 10% of the overall PhD funding.

We include in this another strong recommendation, which is that the programme is opened up to PhD candidates in the public sector. There is no reason why intellectual leadership and innovation are not as important in public agencies and organisations as they are in private business. For the time being, the National Council for Technology and Innovation (*Rådet for Teknologi og Innovation*) could administer the enlargement of the Industrial PhD programme, although with increasing portions of public sector PhD students, relevant knowledge must be made part of the decision-making process. In itself, this platform would increase exchange between the private and public “knowledge sectors” and establish better mobility and new career paths.

Needless to say, continuous evaluation is needed, according to both scientific criteria and relevance/industrial support.

Academic and innovation postgraduate fellowships

With the expansion of the Danish PhD training system, there will be a tremendous output of new PhD degree holders in four to six years. Several of those will have to leave academia. That is generally very good. However, there are certain features that must be considered. First of all, there are still many students – indeed a large majority, according to the survey above – that go to graduate training because they like science. For them, a science career is attractive, and perhaps the sole reason to seek a PhD degree. Secondly, industrial innovation does not just require a PhD, it takes more to secure independent laboratory leaders. Therefore, a training system that seeks to increase competitiveness should look at more advanced training.

For those reasons, and for shaping a sustainable and well-balanced university system, parts of the PhD reform package should include a programme for postgraduate training.²² Some small elements of that are contained in the +100 programme (100 one-year positions).

We suggest that, all in all, about 20% of the total costs in the package should be allocated to postgraduate scholarships, for a period of two to six years after the PhD degree is conferred. One aim is to secure career opportunities for academics; still, the number of scholarships will not be larger than enough to maintain a healthy competition. Another aim would be to provide Danish

²² A Swedish investigation of the effects of post-doctoral visits abroad is presented in Melin (2003).

industry and companies with "innovation postgraduate fellowships". These "innovation postgraduate fellowships" can also be used to develop ideas for "spin-off" companies in line with the "innovation PhD" at DTU. Usually, it is not until after or during the PhD course of studies, when the researcher has gained a certain amount of experience, that the really innovative ideas emerge. We propose that the academic postgraduate programme will require about two thirds of the funds, and the innovation postgraduate stipends one third.

We recommend that the competitive academic postgraduate programme should be managed by *Grundforskningsfonden* (the part that is not already covered by the +100 programme). We recommend that the competitive innovation postgraduate programme should be managed by *Det Strategiske Forskningsråd*. For the latter, we also recommend that cooperation with industry be sought. The innovation postgraduate fellows could preferably carry out their projects in industry and start building research groups there on a fully commercial basis.

In a small way, the innovation postgraduate programme would also supply a mechanism towards a further differentiation of the Danish university system, which would be a good thing. In all likelihood, some universities, and even more obviously, a limited number of firms, will take larger portions of this new funding. If certain universities wish to specialise in industrial orientation, they will then have incentives to do so.

7. Conclusions and Recommendations

General

This evaluation is primarily about the organisation and structure of PhD education in Denmark, and not the substantial quality level. The organisational structure has undergone a number of changes since the early 1990s. Most of those have been necessary in order to increase the number of PhDs and bring it closer to an international level. They are also in line with international trends concerning the Anglo-American PhD. The prescribed time of study has been shortened to three years (although in practice it is often four years) and since 2000 more and more graduate schools have been introduced.

The panel has emphasised that PhD education should be regarded as a public good, as a training programme that improves society and must therefore be funded principally by the state and organised in such a way to cater both to academic and to societal needs.

The panel has found that the current PhD education in general works well and gives adequate training on an international level. We have met dedicated scientists, scholars and academic leaders who care for their students and their PhD programmes. We have seen considerable variety of quality in organisation and structure. Some individual graduate schools and PhD programmes are of an outstanding international quality. We have seen few, if any, instances where PhD education is conducted on a sub-standard level, but it should be noted that PhD candidates are occasionally trained in scientific environments which are not very strong. This is an effect of the general practice in Denmark to train PhDs in any university on any subject. While we do not propose that this order be changed, we do advise that it be observed and that self-restraint in universities be applied to ensure that PhD programmes are concentrated on programmes of academic strength. Several of our recommendations are designed to support concentration and differentiation across the entire national university system as well as within individual universities.

The organisation and structure of Danish graduate training has been modernised since the 1993 reform. It is far more adequate today than it was then and it has been ambitiously reformed to meet the demands of society and industry. However, the panel has observed that the sweeping change has also meant quite a bit of experimentation. Standards and procedures vary. In particular, in only a span of a few years, a plethora of graduate schools with a bewildering variety of properties has been created. While pluralism is certainly a follower of differentiation and creativity, we are convinced that quality can be improved if the mechanisms and incentives of the current structure are changed on a number of key points.

Cultural change - long term perspective

The panel is of the opinion that it is crucial to adopt a perspective on the PhD degree which combines the long term view on goals and purpose with the sense of urgency that is necessary to secure action. The perspective to adopt is one of ongoing transition, a transition that is both formal and cultural. The transition that started in the late 1980s and was spurred by the 1993 reform has taken PhD education from an informal, discipline-based training under "mandarin" professors in the direction of a modern, course-based graduate school. This transition has come some way but has not reached far enough. It must continue and it should be stimulated to progress. The time horizon for continued transition should be ten years, if not more, although the structural changes that the panel recommends are likely to produce considerable effects much earlier, already within one or two PhD cycles. Our recommendations are designed to serve and support the kind of PhD education that will represent high international standards, and optimise international recruitment of top-notch students.

Capacity

In the face of a major increase in PhD enrolment in Denmark, it is essential to consider issues of capacity. The faculty/PhD student ratio varies between institutions but is on the average not more than 1:1. Even considering the fact that some faculty members are not very active researchers or, even, less well-suited supervisors, there is still room for more time and attention devoted to PhD training among faculty. If we assume (based on our site visits, interviews and available data) that 50% of faculty are not very active in PhD training, the ratio is still only 1:2. A typical standard in the best US graduate schools is 1:4, i.e., one professor works with four graduate students.

The panel concludes that there is, generally speaking, a capacity for expansion of PhD training in the Danish university system. Increased enrolment of PhD candidates therefore is attainable without far reaching changes in faculty structure or volume. Danish faculty, however, should enhance their individual capacities to serve as supervisors and leaders of PhD education, and will need support in this. Capacity should also be directed towards organisation and leadership, notably in the responsible build-up of solid graduate schools. The panel recommends focused attention on these issues among universities.

Goals

PhD training before 1993 had a simple, universally accepted, and therefore tacit, goal: academic reproduction. Professors were training future professors. Current and future graduate training

need new and broader goals. Despite this being strongly recommended by the 2000 evaluation panel, a lot remains to be done. The concept of "goals" has largely had a bureaucratic interpretation and is implemented in development contracts and strategic documents, but is less carefully articulated in terms of a socially meaningful mission with the new PhD education.

The panel concludes that the goals of the PhD education are insufficiently articulated. We recommend that a broad discussion in academia and among stakeholders be initiated by the Ministry of Science, Technology and Innovation. We suggest the following as tentative dimensions in such a discussion:

- PhD education is a public good. This is fundamental, and needs to be carefully articulated and widely disseminated to sustain popular and tax payer support of advanced research training for increasing numbers.
- More and higher quality PhD graduates put Denmark on the road to not only a globally competitive society but a society that is better for the citizens of Denmark.
- PhD training is part of internationalisation, including international admissions.
- High international standards are the only viable norm for Denmark.
- Developing the PhD degree is an essential part of enhancing the quality of research and education in Denmark.

It follows from these goals that the panel is sceptical concerning the notion that PhD education could be streamlined to serve primarily as a driver of economic growth or competitiveness. PhD education serves society best when it is a solid, top quality, broad range training of research talent in all areas of science and scholarship.

International standard

The quality *per se* of Danish PhD training is not the commission of the panel. The panel nonetheless acknowledges PhD training to be part of a Danish research system that is at present internationally successful and ranks highly on many indicators.

Still, the panel observes such wide variety of organisation and structure that the full potential of the quality of research in Denmark is not always realised as quality in PhD training. While we do acknowledge the decentralised liberty of the Danish system as a valuable quality in and of itself, we recommend that clear and sustained instruments be put in place to secure a sustained high standard when and wherever PhD training is undertaken. These instruments can be summarised as: