CHAPTER II

What is required to create elite universities?

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Abstract

The world is faced with multiple grand challenges requiring novel approaches and solutions. In particular, scientific breakthroughs, rather than incremental improvements, are needed. In this paper, we outline the frameworks that should be constructed to increase the probability of achieving such breakthroughs and bringing them into practical use. The effort must span the entire educational and research system, and should focus on promoting excellence and elite environments, both in education, research, and knowledge transfer. Using Denmark as a case, we argue that only universities with a strong international standing should be allowed to conduct research.

Keywords: Elite, excellence, entrepreneurial university, education, research, knowledge transfer, private-public partnership, scientific social responsibility.

SCI.DAN.H. 8 · 15 · THE ELITE UNIVERSITY – ROLES AND MODELS
THE ROYAL DANISH ACADEMY OF SCIENCES AND LETTERS · 2017

New is Normal

> The only thing that is constant is change
> Heraclitus (c. 535-475 BCE)

We live in a time of accelerating change. Not only does the rise and fall of dominant technologies occur more quickly than before, but the world is also faced with the uncertainties created by grand challenges, e.g., resource scarcity, demographic change or climate

change, forcing swift adaptation in all sectors and calling for a paradigm shift in science, industry and society.

As a continent, Europe is under pressure. Europe and Denmark have not managed to regain growth after the financial and geopolitical crises in the last decade. Europe is currently challenged by an increasing number of refugees, and over the last decades we have seen the displacement of manufacturing away from Europe to low-cost countries. The resulting loss in jobs, shifting demographics and weaker competitiveness conspire to threaten the long-term viability of European welfare states and give rise to social unrest and political instabilities.

We must not forget, that the income required to fund our fantastic welfare system comes from the private business sector. One of the most important societal framework conditions in helping businesses create value and grow is the access to knowledge and skilled, creative graduates:

> *"A society's competitive advantage will come not from how well its schools teach the multiplication and periodic tables, but from how well they stimulate imagination and creativity."* (Albert Einstein)

Unconventional ideas, innovation, curiosity, and creativity are indeed required in the 21st century, and not least to meet the grand challenges and the UN 17 Sustainable Development Goals of our time. Much can be achieved by combining and implementing existing known technologies, but all projections tell us that scientific and technological breakthroughs, the ability to think outside the box and come up with new innovative solutions, are urgently needed to enable a prosperous and sustainable society in the long term. New innovative breakthrough solutions must often be sought in a cross-disciplinary and holistic approach covering both scientific, technical, and social aspects.

Novel solutions to social challenges are not only a necessity but are also often potential new business opportunities. Europe, and Denmark in particular, are at an advantage in that we possess the social characteristics allowing for cross-disciplinary and cross-sectorial collaboration, but an underlying precondition is always access

to ideas, competences, and skills, originating in research and education. Both must be of the highest international standard, and in a time of austerity, this calls for a focusing of funds at the highest performing institutions – the elite universities.

Universities are unique in the way that education, research, and knowledge exchange with society co-exist on the same premises. The aspect of knowledge transfer has not traditionally been the primary focus at the universities, but has seen a surge in recent years. Strong synergies arise from the co-habitation of the three activities, resulting in what has been termed "the entrepreneurial university". While intertwined in practice, we choose to treat the three activities separately below for reasons of clarity.

Excellence and Elite

We must, however, first try to define what is meant by "excellence". To describe excellence of any kind, the ancient Greeks often used the concept of Arete, which meant an outstanding fitness for purpose.[1] The term is often associated with effectiveness and the use of all faculties to achieve real results. Excellence is thus the capacity of being outstanding or extremely good at fulfilling a specific set of tasks.

Consequently, an elite university excels at all its activities, achieving its multifaceted purpose defined by society. Also relevant when speaking of the performance and excellence of universities is the connotation of quality. Quality as opposed to quantity. The notion goes that focus on sheer quantity carries with it a degeneration of quality; particularly quality of the very highest international rank – excellence. As we shall see below, this trade-off is not inevitable, if we are willing to abandon sameness and allow for a system that challenges a select group at a level above the broader base.

Individual excellence, no doubt, requires talent (intelligence), passion, dedication, and finally – not to be missed – hard work. On the other hand, the individual also requires an environment conducive to the unfolding of potential. In the university context, one should pay heed to the following warning:

1. https://en.wikipedia.org/wiki/Arete_(moral_virtue)

"Creativity/excellence in science, in the arts and in society, cannot be organised. It arises spontaneously from individual talent. Well-run laboratories can foster it, but hierarchical organisations, inflexible, bureaucratic rules, and mountains of futile paperwork can kill it... very quickly. Discoveries cannot be planned; they pop up, like Puck, in unexpected corners."

Max Ferdinand Perutz, the founder of MRC-LMB, 1962 Nobel prize for the structure of hemoglobin, supervisor for Francis Crick (1914-2002).

Excellence in Education

First, we take a look at education, as it is the most important university activity, and the strongest impact universities today have on society is the knowledge embedded in the graduates from the universities.

Over the last decades, we have seen a transition for many universities from serving a few percent of the population into mass universities; e.g., in Denmark, the politically set goal is for 25% of a student year to get a university degree. Without a corresponding surge in teaching and research staff, inevitably, this has brought on harmonization of educations into more streamlined products. Universities concomitantly alter focus to completion times and other non-academic distractions. With the increasing proportion of youngsters going to university, we are today facing the fact that most graduates cannot continue their career in the academic world at the universities but must instead pursue jobs in industry and public institutions, arguably the most efficient form of knowledge transfer to society.

Our observation is that in a given student year, the percentage of academic talents, who for instance have the capacity to successfully complete a PhD degree, is constant over time. The consequence of a higher number of students is that talents constitute a successively smaller fraction over time, and the possibility of challenging them at their own level is weakened.

We must wake up to the fact that we depend on outstanding talents; the group of high achievers who are able to move knowl-

edge frontiers and potentially make the scientific breakthroughs that we so urgently need. As in sports, we must, to a much higher degree, nurture the best talents, although not at the expense of the broader student community. We must challenge those willing and able, so that they may become the next generation of top scientists.

The rate of societal change is increasing, and education must change accordingly. Not by becoming fluid, but by becoming more resilient to change. For instance, this means that too early specialisation should be avoided as specialisation is bound to become obsolete. Instead, core competences, including literacy, numeracy, scientific literacy, and ICT literacy should be emphasized, and the students' level of abstraction should be challenged to strengthen their problem-solving abilities and mental acuity. Such competencies, as well as collaboration skills and creativity, are the most valuable skills for the 21st century entering the era of the 4th industrial revolution, and universities should educate students to meet these needs. Continuing education upon obtaining a degree is a natural extension, and universities also play an important role in this respect.

Excellence in Research

University management has the important task of creating the framework conditions necessary to achieve real scientific breakthroughs. This includes infrastructure (buildings, libraries, professional management, a comprehensive suite of complementary scientific instrumentation) and good technical infrastructure to build its own unique equipment.

An elite university consists of a critical mass of excellent individuals. For that reason, any department head should spend a significant fraction of his/her time identifying, supporting, and retaining the most talented young scholars, and only these. A strategic approach is warranted to facilitate targeted recruitment within specific research areas and avoid fragmentation. Initially, young scientists should be offered help, writing grant applications and should receive mentoring to get started on an independent research path.

In any case, it is very important to stress the independence aspect; we see far too many cases where young scientists remain or become dependent on an older, well established professor and his or her equipment and grants. Therefore, the strategy from the university academic leaders should always be to help young new scholars establish an independent research activity and then... get out of the way. The young (and older) scientist should be given the freedom to define and plan their own research. Time and space for reflection and immersion into a chosen research topic is of the essence. As e.g. Max Perutz articulated very clearly, discoveries and breakthroughs cannot be planned, but pop up in unexpected places, given the right environment, and, usually, after a lot of hard and dedicated work.

Historically speaking, scientific breakthroughs such as e.g. Bohr's atomic model, the invention of the transistor, the integrated circuit (computers), the laser, antibiotics, X-ray imaging, or genome sequencing have not appeared as a result of a top-down, politically driven process. Rather, these breakthroughs of the last century are the results of the investment in basic, fundamental science and fortuitous coincidences, made by the right person at the right time. It is, however, very hard to allow room for serendipity in a Key Performance Indicator-driven university system and it can also be difficult to explain the concept to non-academics. Therefore, it is so important that universities are led by accomplished scholars who have experienced serendipity first hand and thus feel the need to fight for it; see also the section on Academic Leadership below.

The international research community works by the principle of "give and get"; only when you have something to offer, access to the latest scientific developments and results will be given. Peers respond to you, offering unique opportunities, such as access to unique instrumentation or participation in a large centre of excellence. Once you have something to offer, a next step is to develop strategic international partnerships to enhance reputation and consolidate leading positions. This will also help catalyse the attraction of international top scientists.

Long-term stability with respect to funding and infrastructure has a time-honored positive effect on the quality (but not necessar-

ily quantity) of research output. Most university researchers do not have the luxury of long-term funding; this is a result of two tendencies, both, in fact, inspired by the aforementioned focus on excellence: First, a progressively larger fraction of funding is being awarded in open competition and second, the average grant amount has increased. These tendencies conspire to concentrate funding on fewer hands, which tends to make it more difficult for rising stars to gain independence, thus severing the line of succession.

As a result, unfortunately, we see many talented (too often female) PhDs opt out of the academic career path. Add to this, relatively low salaries, time lost on writing unsuccessful grant applications, and the prospect of temporary positions for a decade, and the choice is often straightforward. Politicians and university managements must work to counteract this unfortunate tendency by designing clear career paths, for instance by implementing a US-inspired tenure-track system, which, however, has its own pros and cons.

Excellence in Knowledge Transfer

An elite university must also, in line with the definition above, be a vehicle of knowledge transfer. While a very efficient form of knowledge transfer happens naturally with the employment of young candidates with strong core competences, a university must also collaborate very directly with industry on more strategic and applied aspects. To this end, it is crucial to build upon the competences of researchers trained in basic science, as are only found at universities. In fact, experience shows that the best "applied" scientist is often also the best "basic" scientist and vice versa. This simple truth was formulated early on by Louis Pasteur (1822-1895):

> *There does not exist a category of science to which one can give the name applied science. There are science and the applications of science, bound together as the fruit of the tree which bears it.*

Collaboration with industry has not traditionally carried with it academic merit, so changing from a career path in industry to academ-

ia has been (and often still is) impeded by the fact that researchers are measured with different yardsticks inside and outside academia.

Industry collaboration has therefore not come naturally to academia, and consequently, universities have struggled to establish fruitful collaboration and knowledge exchange with industry. Growing distrust has brought with it the concept of "strategic research", as politicians are not convinced that researchers choose to conduct research in areas relevant to meeting the needs of industry and society. Such criticism is perhaps not entirely unwarranted, as scientists can do much more to position their research for the betterment of society at large (see SSR section below). In addition, and more recently, the realisation that future growth and jobs today critically depend on technological progress has spurred politicians to reallocate even more funding to industry-inspired/driven funding mechanisms.

As alluded to above, such industry-driven research must at all times be "balanced" by curiosity-driven research or we are in imminent danger of sawing off the branch we are sitting on. The real challenge is thus to create sustainable links between groundbreaking research and its exploitation in technologies, which can help meet industry needs and in effect also meet societal challenges.

One particularly raw nerve is the university organisations (so-called Tech Trans Offices, TTOs) handling industry contracts, patent applications and the formation of spin-out companies based on discoveries made by university personnel. With no intent to demean the role of legal aspects in such activities, we notice a desperate need to employ experienced innovators with specific knowledge and experience from real life in this particular area, since these are the only ones who can make qualified assessments of the potential market value of a given discovery. The current incentives set up for TTOs encourage them to file and uphold too many patent applications; a far better approach would be to critically assess the value of a given discovery and only move on with the most promising ones.

In our view, a university TTO is not well placed inside a university. It should be kept an agile separate entity working on fully commercial, for-profit terms and should be part of a University Development Fund (UDF) fully owned by the University. The UDF helps

commercialise research results, write business plans, create startup companies, provide labs with free rent, and offer funds to bridge the gap from lab to incubators to professors and students (alumni students may act as mentors). UDF should own stocks in several companies. Not only does such a construction solve the problem of being able to attract skilled staff on market terms, but it also creates the right incentives that actually encourage knowledge transfer to society in all its forms and shapes.

Scientific social responsibility

It should always be the duty and ambition of scientists to make sure that discoveries with potential societal impact and utility are brought to the proof-of-concept stage and exposed to professional assessment with a view of exploitation and further development in a professional business environment. This is an aspect of what we have denominated *Scientific Social Responsibility* (SSR) as an analogue to industry *Corporate Social Responsibility* (CSR).[2]

In practical terms, this means that the scientist, to a larger extent, should accept a societal responsibility by selecting projects where his or her talent can flourish while at the same time creating value for society; this goes for both the natural sciences, social sciences and the humanities:

> *"It is the responsibility of scientists to position their research for the betterment of society and to help meet the Grand Challenges of our time"*

We propose that accepting and voicing SSR will help researchers regain societal and thereby political trust and hopefully counteract the allocation of funds for fruitless top-down strategic projects and attempts at political control, often resulting in non-applicable applied science.

2. P. Krogsgaard-Larsen, P. Thostrup, F. Besenbacher, Angew. Chem. Int. Ed. 2011, 50, 10738 – 10740.

Public-Private Partnership

In all likelihood, we are going to see an even stronger shift in academia-industry collaboration towards taking industry needs as the starting point for the definition of the subject matter of a given project. While this, by some, may be seen as a degradation of academic freedom, it is still to be preferred over someone external (as in "strategic") to the collaboration, doing the defining. In any case, most scientists and students in fact find it very motivating to see concrete improvements or new products appearing as a result of their endeavors.

An elite university, performing well on the aspect of knowledge transfer, thus knows how to support the formation of lasting, trustful relationships between its academics and companies. As is the case for research careers or department reputation, there is usually no quick way to kick start industry collaboration. University management has a role to play in facilitating meetings between researchers but the real work and point of contact is done between level researchers communicating freely. Experience shows that this is only possible when a company employs scientists, i.e. when the company in question is either quite large and/or based on advanced technologies. If small and medium-sized enterprises (SMEs, in fact most European companies) are to become more strongly involved, other modes of collaboration, clustering, and facilitators may be needed.

In general, however, the unfortunate truth is that Europe still falls behind countries like the US and Israel in reaping the benefits from our high level of research, i.e. we fail to turn new discoveries into business. Closer interaction between private and public actors, so-called public-private partnership, is needed, both to ensure faster exploitation of new discoveries but, importantly, also because grand challenges, which impact several societal aspects at once, can only be met through cross-sectorial and cross-disciplinary collaboration.

One such successful approach is the Innovation Fund Denmark (IFD), which funds industry-driven projects contributing to growth and job creation. IFD has taken a very focused approach to only fund projects, which actually benefit industry but with different in-

struments targeting large companies, SMEs, and budding innovators. We are encouraged by the fact that the European Commission has recently proposed a fund quite similar to IFD.

Academic Leadership

Excellent academic leadership is required and crucial for universities to fulfill their purposes in education, research, and innovation. Today we see a stronger focus on leadership at universities, which were previously often governed by peer councils designed in an age where change came slowly. The flipside of professional leadership and the adjoining implementation of *new public management* is the very unfortunate tendency of über-bureaucratisation. Following the Perutz quote above, bureaucracy is to be minimised at all cost, so this is an unfortunate development, to say the least.

Universities should not be led by managers without strong research and education experience – we need to put "Socrates in the Board Room"[3] and instate individuals who are accomplished scholars and respected by their peers. This makes scholars more credible because they are the only ones with a deep understanding of the core business of a university. The leadership must work to set quality thresholds for the university and must hire outstanding deans and heads of departments following Weil's law:

> *First-rate people hire other first-rate people, second-rate people hire third-rate people and third-rate people hire fifth-rate people.*
> André Weil, French mathematician (1906-1998)

Project management is, however, the central type of academic leadership in a university organisation. This is where the real work is done. Project management must be prioritised and the project manager must set the right team, driven by high academic standards towards new insight. These research managers deserve academic

3. Amanda H. Goodall, Socrates in the Boardroom: Why Research Universities Should Be Led by Top Scholars, Princeton University Press, 2010.

freedom and sufficient resources. These are not privileges given, but earned, by those who demonstrate excellent and dynamic research results.

Case: The Future of Danish Elite Universities

The Danish educational system has been the battleground for numerous ideological battles over decades but has nonetheless stayed relatively stable. In international comparisons, it remains a very expensive system that does not deliver top-ranking results at all levels. At present, Danish primary-school students only attain a place in the top 25 in both reading and mathematics. These disappointing rankings are explained as a result of a schooling system which does not focus on rote learning but rather emphasizes critical and independent thinking.

All eight Danish universities deliver education at both Bachelor's, Master's and PhD levels. Few Danish students, unlike in the US for example, finish their studies at the Bachelor's level, as students have a *right* to be admitted to graduate studies after having completed a Bachelor's degree, thus contributing to a degree of general over-education. As a result, there is practically no labor market for Bachelors.

The entire Danish schooling system is free. At university level, there are no tuition fees and students are actually paid approximately 10,000 $ per year, both at the Bachelor's and Master's level. The argument behind this generous system was originally the need to break with "negative social inheritance", i.e. the fact that children of uneducated parents are unlikely to complete a higher education. Not surprisingly, the effect has shown to be rather limited. Furthermore, this may also be why some students are seen to take a lax approach to their studies; some report spending only 25 hours per week studying during Bachelor's and Master's studies, including classes at the university. Obviously, this is far too little, although many students do a great and very dedicated job. Because of this, there is good reason to advocate elite programs for the best talents who are also prepared to prioritise their studies and work hard.

One concrete proposal that could kill two birds (i.e. over-educa-

tion and misspent funds) with one stone, is to limit economical support to the Bachelor level and offer interest-free loans at the Master's level. The money saved on economic support should not be removed from the university system, though, but rather reinvested in research and innovation. At the same time, the right to continue at Master's level after a Bachelor should be revoked.

As a PhD student at Danish Universities, you receive what amounts to a decent salary, about 45,000 $ per year, which makes the Danish PhD program extremely lucrative and expensive compared to international standards. With a surge in the number of PhD students over the last 10-15 years, the talent pool of excellent scholars has been emptied. Without the ability and effort to attract the necessary number of outstanding foreign talents, a high percentage of a given student year continues onto PhD studies, again contributing to the general over-education in the Danish system.

In addition to over-education in the higher education system, vocational educations have seen a strong decline in student mass over the last decade, most likely because this type of education has become less prestigious in the Danish society. In an attempt to meet a perceived need, and sometimes as a result of an institution's own ambitions, vocational educations have been the subject of academisation, i.e. a stronger focus on theoretical aspects. While it is necessary to teach digital competences, vocational education still has practical elements that are in strong demand. The Danish society heavily depends on excellence in the vocational sector as well.

In general, Denmark is performing very well in international comparisons on research performance relative to the number of inhabitants. Denmark usually appears in the top 3-5 and has done so for decades, probably reflecting a relatively stable university system and funding situation over the same period of time.

Denmark has eight universities but only three elite universities in the top 100 in international rankings; for a country with about 5 million inhabitants, eight research universities is a (too) high number caused by regional considerations. As discussed above, the right talent mass is of the essence for producing excellent research and in the current landscape, we indeed see too many subcritical research and educational environments.

The natural consequences of the considerations in the preceding sections are *mergers* and *work sharing*. While the former may be difficult to implement on a short timescale, incentives should at least be set up, encouraging vice-chancellors at Danish Universities to improve the coordination of the distribution of different research fields, and hence studies, among universities. This would also have the effect of "forcing" students to travel to the university where their study of choice is offered. This is the case in most other countries, and Danish students would be able to do the same.

In a time of dwindling research funds, a next natural step would be to limit the elite international research activities to the three universities in the 100-international ranking. Regional universities could still retain Bachelor's level programs and maybe Master's level as well, which, as we have seen, will become more important in the future. Sometimes, students would have to relocate to attend a Master's program. This model, practiced in many other countries, seems to meet both regional and national needs.

In terms of knowledge transfer to society, Denmark does not match its high ranking in research performance. Performance below par is seen both in the number of university spin-outs and lucrative patents. The recently established Innovation Fund Denmark (see above) appears to be making an important contribution towards improving the degree of knowledge transfer from universities to society, but the Danish TTO system is not well-functioning and needs to be completely reconstructed. We need to improve our ability to commercialise research and create start-ups. One way forward would be to have the TTO become part of an excellent separate for-profit company e.g. a "University Development Fund (UDF)", owned by the Universities or the government, but operated from a professional business angle. The UDF should provide funds to bridge the gap from lab to incubators to professors and students and successful alumni students may act as mentors. The UDF should be able to own stocks in the companies, and initial investments in start-up companies can be protected from dilution by an Investment Opportunities Fund, run by the UDF. The UDF might reinvest in young talented scholars doing excellent basic research during, for example, their PhD and postdoc

studies, since they will be the future customers of the University Development Fund.

Now is the wrong time for cuts in the educational sector. Money spent on education, research, and innovation is an investment in a future more unpredictable and more subject to change than ever. The only thing constant in the era of the 4th industrial revolution is change. Creativity/excellence in science, in the arts and in society, cannot be organised. It arises spontaneously from individual talent. Well-run universities can foster it. This is how one creates elite universities fulfilling their purpose in both education, research and SSR.