CHAPTER 10

Research and Education
New Roles, New Instruments

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INTRODUCTION

U niversities were organized and have developed over the years according to a few valuable principles. Nothing epitomizes these principles better than two simple statements outlined by Wilhelm Von Humbold in the last century. The first states that research and education (*Forschung und Lehre*) should be indivisible. Research brings competence and enthusiasm to education, and education brings new people and fresh ideas to research. The second statement emphasizes the environment of solitude and freedom (*Einsamkeit und Freiheit*) that should prevail in universities. Solitude protects academics from unwarranted outside pressures, and freedom allows their natural curiosity and creativity to develop. These four qualities have served the university well over the years and have guided the establishment of universities as we know them today. Solitude influenced the development of the university campus, for example. Freedom encouraged the award of tenure and the management structure of the university. Research demanded the establishment of research institutes and programs and is the guiding force in the programs of both undergraduate and graduate schools.

There is no reason to question or discard principles that have served the university so well over the centuries. Indeed, they are at the center of the social contract between the university and its environment. We should, however, periodically reevaluate our goals and adapt the principles to our new

world. This reevaluation is happening now and it is being forced upon us by intellectual, economic, and political changes.

Universities are part of a general knowledge society that is expanding at an increasingly greater pace. The value of this knowledge is no mere abstraction. Knowledge is a critical renewable resource. Producing, packaging, and distributing knowledge are important businesses. Universities cannot remain unchanged if they hope to play a central role in an important and fast changing economic activity. They need to adapt their goals, their structure, and their instruments.

RESEARCH AND INNOVATION

Traditionally, research in universities is fundamental, open, and free. It is fundamental insofar as academics are admired and rewarded when they discover new areas or solve well-known problems. The librarian's citation index rewards the initiators of a research topic, but nothing is considered so valuable as to shed light on an issue that others have tried for years or centuries to resolve. Research in universities is open to the extent that publications are still considered the main measure of success. An academic career is supposed to advance continuously with a couple of publications per year. Promotion, tenure, and status are related to publications. Finally, research in universities is free from the intrusions of management. Each professor and each researcher is supposed to decide freely where and when he or she is committing his or her brain cycles. Freedom is considered an essential aspect of creativity. The drive and the impulses to succeed are supposed to come from within. Researchers who cannot define their research agendas and have a limited spirit of independence are considered second rate.

Research is not intended to be a sterile intellectual pastime. It is supposed to have an end. It is supposed to create new knowledge, to clarify, and to innovate. The results of this innovation process, the new ideas, are transmitted through two channels. The first is publication. Publication is not a goal in itself. It is a communication conduit to other contemporary or future researchers. The second channel is through the heads of students. Students, especially graduate students, participate in research projects and transmit new knowledge wherever they go. The pressure on students to change institutions or to go into industry helps transmit many more ideas and experiences, most of which cannot be captured by publication alone.

This research environment, which evolved over the years in universities, is entrenched in structures, in procedures, and, most important, in the mentalities of the persons involved. However, two developments create difficulties. First, research results and the potential applications of innovation are becoming valuable in economic terms. The economic interests are so enormous that

they distort the whole picture. Second, the timeframes are becoming shorter. Research results have to be promoted immediately or they lose their value. These two new developments create a very competitive and dynamic research market. It is questionable whether universities can effectively compete in this market with their old framework.

THE RESEARCH MARKET

It is not unusual for successful companies to obtain more than 50 percent of their earnings from products that were not around five years ago. This trend implies that companies are forced by the market to package new products at an ever increasing pace. Innovation is becoming a strategic advantage more important than cost cutting or financial strength. Especially in high-tech areas, such as information technology, a company's very existence can be in danger if it misses a few important innovations.

Companies once had separate research laboratories and divisions that were operating rather like universities, although the work was less fundamental, less open, and more controlled. The hope was that these research centers, if you will, could be directed to work on significant problems for the future development of the company. In addition, company research was doing technology tracking, following developments in other research laboratories. Finally, companies would often have pools of experts to draw upon in task forces to help guide management and give valuable consulting to the operating divisions.

This model of semi-academic research for companies is becoming obsolete. First, the cost of the research division is considerable, and management questions it under the pressure of shareholder value. Second, it is difficult to direct research according to the company needs. Third, technology transfer between research and operating divisions is always problematic. Finally, research often produces results that are valuable but incompatible with company strategy.

Companies are responding by phasing out, distributing, or co-opting their research divisions. Phasing out means slowly reducing and redistributing the staff. Distributing means moving research groups directly to the operating divisions. Co-opting means that operating divisions participate in the financing and management of research. All these solutions acknowledge indirectly that a company's innovation strategy is too important to rest solely on the research division. Companies increasingly obtain the innovation they need directly from outside. There are many different ways for a company to buy innovation. It can outsource research projects. It can participate in research projects or in consortia with specific goals. It can buy or exchange innovation from other companies in the form of patents and licenses. It can merge with or buy out other companies. It can participate in the capital of other companies.

Finally, it can run its own venture capital operations, spinning off companies or encouraging start ups. All these operations create a large research and innovation market.

Universities offering only traditional research find it hard to participate in this market. They have a dual problem. First, they need to aggressively promote themselves and their results in this market. Second, they need to collect the benefits due to them from this market. In many universities, both operations are difficult. Academics are not necessarily the best marketing persons. Some of them consider marketing to be contrary to scientific valor. Others are interested in promoting themselves and their personal interests and not necessarily the university's interests. In addition, university administrations, although excellent in controlling spending, are not necessarily good in obtaining money from the research market.

Some universities have learned that research cannot just be given away when people knock on the door. They run technology-transfer operations, patent offices, techno-parks, and the like. They sign contracts with companies, they reserve exploitation rights, they charge overheads on research projects, and they finance staff with soft money. All these are potential instruments. There is, however, an important policy question. To what extent should a university enter the innovation market, and how? To be sure, universities should move decisively and aggressively in the research market; they cannot afford to stay out. The research market is and will continue to be very lucrative. Universities outside this market will find it impossible to finance academic activities or obtain top people. Slowly, there will be a concentration of top talent where the best financial and infrastructural conditions exist. The rest of the universities will slowly drift downward to the level of the community college. Even universities with large endowment funds, or strong alumni associations, or strong historical roots, or good political support will find it hard to compete. The research market will eventually designate winners and losers. One sees already the first signs of companies concentrating their attention and their financing on universities that best fit their interests.

COMPETENCE CENTERS

Universities cannot effectively compete with innovation-centered companies (the universities' real competitors) in a research market by only adapting their traditional structures. A technology transfer office and a couple of lawyers and marketing people are not enough. They have to develop special structures that operate practically as separate companies. We propose a structure of competence centers.

A university competence center should be thought of as a separate company wholly owned, or at least controlled, by the university with many other

potential industrial partners. It should be managed as a company with clear goals and a business plan. Its staff can be shared with the university but staff members would have other responsibilities and other roles while working in the center. A competence center would survive in business terms only for as long as it can obtain sufficient funds. The university plays a role as a holding company relative to its competence centers. It launches them, closes them, or carries them over in times of need.

A competence center does all the things that academic research is allergic to. It contacts companies, builds prototypes, runs certification, sells patents and licenses, creates spin-offs, and runs industrial labs. It has a small number of more permanent staff, the rest being on short-term contracts. It operates as a small-sized (100–150 persons) innovation company. It feeds on the academic research and produces results for the innovation market.

Competence centers are not aligned according to academic faculties. They combine disciplines as they are needed by the innovation market. Not every faculty needs a center, and centers may combine talents coming from different faculties or departments.

A competence center cannot operate on a profit basis without some subsidies. A reasonable mix is 50/50 between institutional funding and re-sources coming from outside. The 50 percent institutional funding may come from the university (perhaps as people's time, as buildings, or as infrastruc-ture); from local, regional, and national government; and from some large sponsors. The other 50 percent may be obtained through contracts, small or large, short or long, depending on the business plan.

Competence centers tie the university to the economic activity and allow it to be very visible in specific areas. In addition, they indirectly provide a great environment for training students. Finally, competence centers have a pool of practical talent that can be used for education or training for the rest of the university. Most universities already run such a competence center, albeit for special purposes, such as a university hospital.

EDUCATION AS STORYTELLING

Teaching and learning form a complicated process of minds coming together and exchanging knowledge. We will not even attempt to discuss here the fine details of such an environment. However, two components of the process stand out. First, storytelling is an important component of teaching in that it describes in abstract but vivid terms what needs to be learned. Second, experience-gathering is an equally important component that brings more concrete and direct evidence to the subject. In this section, we will discuss storytelling and in the next section experience-gathering.

Storytelling goes back to the beginning of knowledge transfer. One can visualize a group of people listening to somebody explaining what he knew, followed by a discussion on clarifications. No infrastructure or learning method was needed except a common language.

Storytelling evolved over the years and eventually became ex-cathedra lecturing, such as we observe today in universities. The fact that blackboards have yielded today to transparencies, slides, and PowerPoint images does not imply any great change. On the contrary, part of the interaction was lost as the groups became larger and the lectures more formal. Storytelling is assisted by written documents, and by the library as a place for individual learning and contemplation.

When looking back at storytelling in areas outside education, we see a dramatic change. New technologies appeared and changed storytelling in film, television, CD-ROMs, Web TV, and the like. Still, education remained untouched, apart from an ill-fated attempt to introduce television. In many universities lecturing goes on as before, while computers are used to prepare the overheads.

We believe that education via storytelling will change dramatically over the next few years. This change is practically feasible and economically inevitable for a number of reasons. First, the technology is here, is affordable, and is easy to use. From the Web to multimedia, we see a new generation of tools that are widely available and cheap. Second, content is becoming more widely available by the day. Some of it is of good quality, and its range and applicability will increase. Third, a new generation of university teachers knows how to use multimedia and pump the Internet for information. Finally, students are becoming computer-literate, and expect lectures to be exciting and up-to-date.

How will all this affect university lecturing? First, book libraries will gradually be replaced by all-encompassing digital libraries available on the networks. Libraries will be there, but they will play a limited role as rare document collections. Most people will not need to consult the real thing. Second, students will have access to too much information. They will come to lectures to be motivated and to interact with other people. Professors will need to be mentors rather than explainers. Third, much content will be available for import. Lengthy stylized explanations need not be repeated. They will be available on demand. Fourth, experts will become available on demand through telepresence to enhance the experience and bring new elements into the discussion. Fifth, interactions will increase. Most students will come to a lecture mainly to interact. The lecture will become more of a discussion forum. Finally, many passive spectators may choose to drop in during real time or to examine the event later at their convenience.

In summary, a lecture can become a performance with one moderator, many active participants, packaged material, a script, much spontaneity, a present audience, and a remote and more passive audience. It is storytelling in the best possible tradition. On the other hand, boring repetition of explanations by the same person on material widely available is totally unnecessary. It is the equivalent of monks copying books in an age of printing presses. It will probably become obsolete.

EDUCATION AS EXPERIENCE-GATHERING

Storytelling is not sufficient to transmit knowledge. People need direct verification through experience. In this way, the abstractions, the words, are complemented with personal and direct involvement. Over the years in universities, experience-gathering was also stylized in labs and visits. Labs were able to duplicate real phenomena in small scale, and visits allowed direct contact. We will discuss the ways that these kinds of experiences can be changed or even substituted by using modern technology.

Labs were never the real thing; they were only artifacts representing the real thing. When one performs an experiment it is real, but it is not of the same scale as a natural phenomenon. Two mental exercises are necessary: first, to visualize the phenomenon on the basis of what is measured, and, second, to imagine the phenomenon at its real scale. There is, therefore, some kind of augmented reality with one's imagination.

In visits, one is confronted with a similar experience. Since the visit is short, one doesn't have time to see everything; the rest must be imagined. Moreover, a single glimpse lets many details escape. Part of the abstraction is verifiable but not the details. Again, one has to imagine both the details and the invisible parts to get a whole picture. One augments reality on the basis of the abstractions one knows. This is the reason why a visit to a museum or a city is much more beneficial when one has studied beforehand.

What modern technology offers in terms of virtual reality is the ability to experience phenomena directly and with many senses. In addition, an exciting interactive environment can be installed so that a person can interact in real time and concentrate on a much more personalized tour. In addition, one can superimpose abstraction and augmented reality and play out different hypotheses.

We expect many lab sessions and on-site visits to be partially replaced by augmented reality experiences. We emphasize "partially" because people will always be attracted to real all-encompassing experiences. The huge advantages of this environment are that it can be inexpensive, personalized, repeatable, interactive, and remote. It lends itself to many experiences where visits are impossible or expensive, or where experiments are either destructive or

dangerous. The whole environment of education as experience-gathering will be revolutionized with these techniques.

TELELEARNING SERVICES

Technology offers new possibilities in the teaching–learning process. It also opens wide a new market: telelearning services. Telelearning is not new. Special universities have been formed, so-called "free universities," to offer telelearning, first with mail and then with combinations of mail, radio, and television. In addition, many universities are offering continuous education at least regionally and often based on analog video technology.

However, two developments influence this area tremendously. First, globalization has unleashed new competitive pressures. Companies need great competence in their personnel. This, in turn, creates a need for continuous learning on an unprecedented scale. Companies respond in different ways, from renewing their personnel to creating their own internal universities. Clearly, the continuous education market will be large. It is not at all clear how this market will be satisfied. Nor is it clear who will be paying for the retraining: the employees, the companies, or the state?

Universities have always considered continuous education to be a side activity. Professors were not so excited about offering continuous education courses. They often duplicated their normal courses in the evening. The attendees were paying small fees and were not very demanding. Too often they were retired persons eager to fill their time with some intellectual activity. This is far from what is needed today. The potential clients are willing to pay but they expect top quality service. They need courses fitted to their needs, up-to-date and personalized. They also expect perfect organization. In short, they are demanding clients in a competitive market. Universities are often geared to serve captive clients in a monopolistic market. To be a player in the new continuous education market, universities need to change.

The second development is technological. The global availability of the Internet, the availability of broadband networks, the arrival of affordable multi-media PCs, digital TV, and many other technologies create a new environment. The emerging standards provide a stable platform for the production, packaging, and dissemination of content. Companies and institutions are racing to position themselves in this market. The universities have the knowledge workers, but they only have a limited time to react decisively.

There are three aspects of telelearning services: production, packaging, and distribution. Universities can enter any one area or all three. Production of educational content is probably the most lucrative but the most difficult. It needs professional studio techniques, specialized personnel, and high standards. Not every professor can be a television star and not every professor can

be schooled to be a great content provider. Putting a camera in a classroom is not content production. We doubt seriously whether universities can enter into content production by themselves. They need alliances. The best is to combine their talent with media producing companies. The resulting units should operate as separate companies with clear business plans. Universities should move quickly—specialized media production companies may not need them forever.

Packaging of content in programs is more accessible. The university uses its reputation and its experience in putting together course modules and in integrating courses into programs. In addition, the award of a certificate or a diploma offers a certification much desired by clients. Successful telelearning packages need to respond to market needs. The university cannot just offer what it has. It will also be wise to input the best quality content, and unrealistic to expect that all the best content can be produced locally.

Finally, distribution of telelearning services uses the regional contents of a university, plus its facilities, its infrastructure, and its personnel as animators. Universities need not distribute their own programs. They can distribute world class programs packaged and produced elsewhere. It sounds radical for a university to distribute a telelearning package with a certificate coming from another university. It is, however, inevitable if the local university does not have something better for the market needs. The separation of telelearning services in production, packaging, and distribution mirrors what has already happened in television. Global players are producing content. Regional players are packaging content in television programs. Local players are distributing the programs.

Universities may choose to enter any of these three sectors. They have to consider possible alliances, to set up proper structures, and to take the matter very seriously. Universities that come late or half heartedly will be pushed out. Once out, universities risk staying out. Universities that think that language or any other legal or artificial barrier will protect them from competitors are wrong. This is a global, competitive business in the same way as film or television. The only way to survive is to compete successfully globally.

NEW ROLES AND STRUCTURES

Over the years, universities have developed a stable structure in terms of schools, faculties, and departments. They have also developed levels for personnel in terms of deans, professors, and associate and assistant professors. Academic research is fitted approximately into the same structure. Research areas correspond to the education structure. In addition, deans are sort of research directors, professors research fellows, associate professors senior researchers, and assistant professors junior researchers.

We see lately that the two directions, education and research, have some difficulties co-existing in the same structure. Research is becoming interdisciplinary and evolves more dynamically. Educational structures are tied with programs and degrees and have difficulty changing. In addition, some professors are great at teaching but mediocre in research, and great researchers often have no interest in teaching. Such difficulties are usually settled in an ad hoc manner to avoid creating separate structures.

If basic education and academic research can somehow co-exist in the same structures, it is not at all the case for competence centers and telelearning services. They both need to respond quickly to markets outside the university, and they cannot survive in the existing structures of the university.

Besides being viewed as separate entities with their own management structure, competence centers should have a strong director, project leaders, and project members. Directors would be term-appointed. Project leaders and project members would be dynamically assigned according to the project mix, and would be on temporary appointments. Tenure makes no sense for such a unit, which is business-oriented and operates according to usual business practices.

Telelearning services should also be organized as business units. Each service relating to a particular economic sector (not academic discipline) should have a strong manager, program supervisors, and course animators. Service managers would be term-appointed. Program supervisors and course animators would be dynamically assigned according to the services offered. Again, tenure does not makes sense, it is a business service unit.

The fact that both competence centers and telelearning services operate in a businesslike fashion outside the structures of the university facilitates running them as alliances with other companies as partners. If these two sectors need to have new structures, it is worthwhile to reconsider also the traditional sectors of basic education and academic research. We would therefore suggest as a mental exercise that academic research be organized outside basic education in a research division with research institutes in only those areas where the university has strong research interests. Research institutes would have research directors with senior and junior researchers as personnel. It is debatable whether any one of these persons needs tenure. Research directors would be term-appointed, and senior and junior researchers would be temporary and assigned on academic research projects.

Why should basic education persons need tenure? For historical reasons perhaps, but there is nothing to distinguish them from the rest of the units. Deans, professors, and junior professors can all be term appointed. Are there any staff that need to be permanent? In the same way as in other service sectors, legal offices, and consulting or financial services, some persons considered as partners need to be tenured. Some deans, research directors, compe-

tence center directors, or telelearning service managers can be offered tenure as an acknowledgement of long and valuable service and close identification with the institution.

CONCLUSIONS

Universities were once thought of mainly as places for educating the elite. Research and discovery was an intellectual exercise. The products of this research were freely and widely distributed. Now universities are an important economic actor. They can be leveraged for economic gain both individually and regionally. Universities cannot stay the same when their research by-product (educating people is the main product) becomes a strategic economic advantage.

Universities were once organized for educating young people for a limited time period, say 5 to 10 years. People, however, are increasingly finding that they constantly need an upgrade in their skills during their lifetime. Continuous lifelong learning is becoming a factor forced by globalization and the fast pace of innovation. Continuous learning was once a niche activity for universities. It may take such proportions in the future that university education becomes a niche activity of a vast continuous learning process.

We have outlined many possible changes coming to the university from outside market developments and exciting new technologies. We have proposed the organization of a university in the following four sectors:

1. Basic education with a traditional structure of faculties and departments and traditional levels of authority as deans, professors, and junior professors
2. Academic research with a structure of research institutes with research directors and senior and junior researchers
3. Competence centers with center directors, project leaders, and project members
4. Teleteaching services with service managers, program supervisors, and course animators

Each of the four activities is optional for an institution. One can perhaps have only basic education, as with community colleges. One can have only academic research, as with research centers on fundamental research. One can have only competence centers, as research centers on applied research. Finally, one can have only teleteaching services, as with some free universities or training companies.

An institution can adopt interesting combinations. For example, basic education and teleteaching services, or academic research and competence centers. It can have basic education and academic research, as do most

universities. It can have competence centers and telelearning services. Finally, it can have potentially all of them but not necessarily in all scientific areas.

The advantage of combining many sectors among basic education, academic research, competence centers, and teleteaching services is that one can reinforce the other. Reputation in one can help launch the other. People can be shared in different roles in different activities. Finally, people can move between activities, playing different roles at different times. It may, for instance, be advantageous for a person to move from academic research to competence centers or from basic education to telelearning services.

A university cannot and should not enter all activities in all scientific areas. A strict selection is required to position the university. This selection implies that some hard and unpopular decisions have to be made. Whether a university can, with today's management procedures, arrive at such decisions is a different problem. One hopes that it will be discussed in some companion paper on university governance.

Universities developed over the years, combining education and research in a free and isolated environment. Education and research (*Forschung und Lehre*) were served in a perfect solitude and freedom (*Einsamkeit und Freiheit*). We see two new directions coming: market-driven competence centers and telelearning services. Universities must decide if, when, how, and with whom they want to enter these markets. This decision is far more important than using particular technologies to streamline what already exists. Universities cannot for long avoid taking these decisions. Their monopoly as knowledge providers, packagers, and distributors is breaking up on all fronts. Universities should realize that they compete not only with other universities. They are part of a gigantic, lucrative, and extremely competitive knowledge business that is shaping our society. They have to play a strong role if they hope to play any role at all.