


# Adding Licensing and Venture Creation to a University Mission of Open Exchange

Triple Helix Conference 2005: Paper ID# A307

# Adding Licensing and Venture Creation to a University Mission of Open Exchange

Mats A. Lundqvist, Chalmers University of Technology

mats.lundqvist@chalmers.se

Karen L. Williams, Center for Intellectual Property studies

Chalmers University of Technology & Gothenburg University

**Key Words:** university technology transfer, open science, licensing, and venture creation

**Abstract**

Universities have, for a long time, gained societal recognition and interest through their ability to govern a global system of open science and open exchange as well as a system for building of recognition capital, for researchers and students. Universities are increasingly becoming commercial actors, particularly in terms of performing licensing activities and investing in ventures. As universities take on new roles and develop new practices for commodifying new knowledge into licenses or new ventures, questions arise about the future role and idea of universities as such, as well as around the actual practical and managerial consequences. However, if universities are to walk down paths of commodification at all – and strong "defacto" arguments for this can be made today – there is reason to search for a "new intellectual infrastructure" of universities, in which the commercial roles and practices of universities can converge and make sense in the knowledge economy. While providing two significantly different case illustrations – Columbia University in New York and Chalmers School of Entrepreneurship in Sweden – with some converging trends, the paper conceptualizes elements of a new university infrastructure both in terms of the role played and norms applied, as well as in terms of an object-oriented process for commodifying inventions into intellectual property (IP).

**Introduction**

This paper concerns the way in which universities can provide a new intellectual infrastructure for knowledge utilization and commercialization. The concept of infrastructure is normally associated with roads, rail and other public (physical) goods in society upon which an industrial economy and society can be built. Many would agree that the notion of infrastructure can also include intellectual elements, such as common norms and roles needed for a complex society to work. Many would also see institutions of higher education and research – here lumped together under the name universities – as key providers of such infrastructure, by educating people into important professions and roles in the political, economical and cultural spheres of society as well as contributing with scientific knowledge to our culture and economy.

However, while it is obvious for us that infrastructure in terms of roads, professions, etc. should help us move "from point A to point B" (whether physically or intellectually), this is not yet the case regarding processes of commodifying university research into intellectual property (IP) and economic wealth. Probably the most dominant perspective on the university's role in the surrounding society points at a boundary that is seemingly difficult to transcend (see Figure 1). According to this view, the university, on one side, through open exchange and open science is supposed to discover breakthrough innovations, and the surrounding economy, on the other side – somehow – is supposed to "pick up" the innovation and generate economic wealth. In fact, the boundary between a world of open exchange, in which the capital is what we, primarily, choose to call recognition capital, and a world of market exchange, where the capital is financial, is often called the "valley of death", a perhaps dramatic metaphor pointing at the need for a new infrastructure.

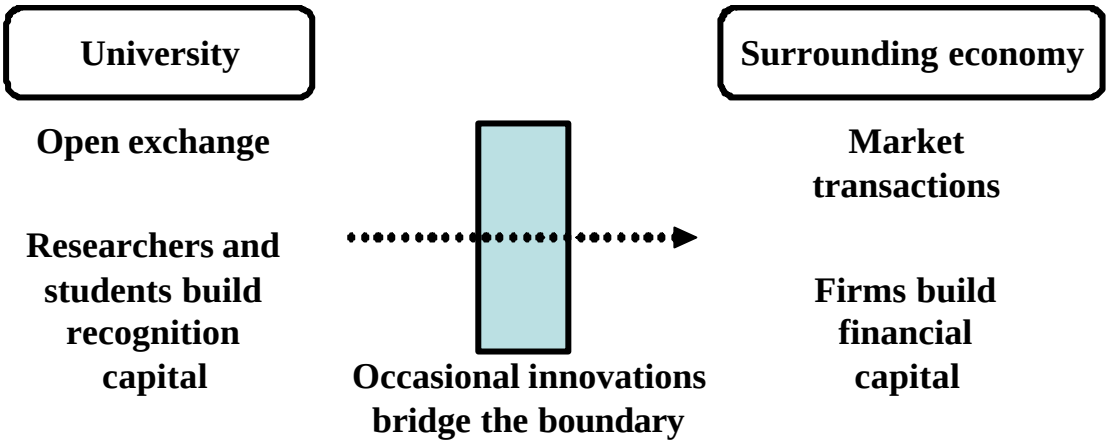


*Figure 1. The strong image of a barrier between the university and the surrounding society as regards the commercializing of new knowledge can partly be explained by different institutional roles.*

Many attempts to transcend the barrier have been made by universities and national policies. The most famous examples, such as MIT and Stanford, are today embedded in innovative cultures consisting of informally networked people (often former students) bridging the boundary and creating value[1]. Because of this culture, the active involvement of university officials has been reduced, as compared to the "pioneering ages" when people like Vannevar Bush and Fredric Terman were instrumental in the creation of firms, such as Hewlett Packard, and institutions, such as technology licensing and the venture capital firm[2]. Nevertheless, early university pioneering efforts were diffused primarily in the U.S. university system. Since 1980, when the Bayh-Dole Act[3] was enacted, an official and regulatory practice has developed in the US, showing, perhaps, the strongest example today of how the boundary, instead of being a barrier, can become a managed interface. Technology Transfer Offices (TTOs) or Offices of Technology Licensing (OTLs) were built at the universities, focusing on capturing university inventions as IP and issuing licenses, while paying respect to the open

[1] Saxenian, A. 1994. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128.* Cambridge Harvard University Press; Etzkowitz, H. 2002. *MIT and the Rise of Entrepreneurial Science, Routledge, London*

[2] Etzkowitz, H. 2002. *MIT and the Rise of Entrepreneurial Science*, Routledge, London.

[3] 35 U.S.C. §200-212; 37 C.F.R. Part 401. For more information on Bayh-Dole within this paper, see section *University as licensor – the Columbia example*. p. 12

exchange mission of the university, as well as allowing the public, the university, the inventor and commercial developers to share in the benefits of the transfer (see Figure 2).

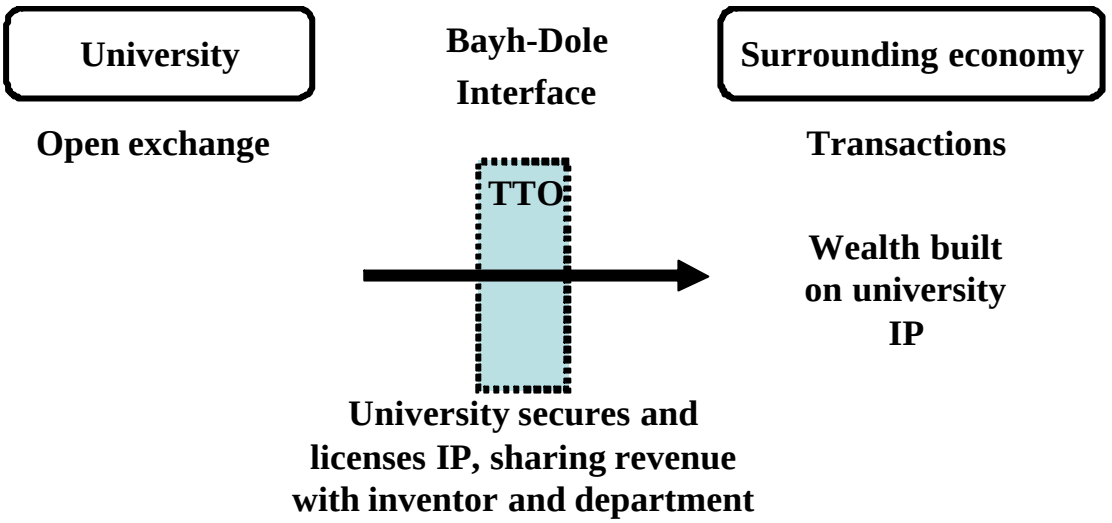


*Figure 2. University technology transfer offices (TTOs) in the U.S. manage the interface between open exchange and market transactions under the Bayh-Dole regulation from 1980.*

In a recent study of twelve, specifically selected, U.S. universities, conclusions found that the most prominent denominator for U.S. universities that have been particularly successful in their technology transfer and commercialization efforts was the adoption of a central, integral focus on "being a player" in regional economic development[4]. This "player" recognition occurred both within and outside the universities. Most of the twelve universities, acknowledged in the study for their success, had a systemic and integrated approach to technology partnering, where technology transfer was part of a larger whole. The universities also strived to develop long-term collaboration projects with industry, which often developed into technology transfer relationships. In addition, the twelve universities, in comparison to others, offered extensive executive training, which enabled them to establish close relationships with industrial partners.

[4] Tornatzky, L.G., Waugaman, P.G. and Gray, D.O. 2002. *Innovation U: New University Roles in the Knowledge Economy*, Research Triangle Park, N.C.: Southern Growth Policies Board.

The twelve universities had in-house competencies in patenting, licensing and commercialization, and had developed expertise in launching start-ups, encouraging their faculty to participate in, though not necessarily run the ventures. Most of the twelve universities were also actively involved in fostering local entrepreneurial ventures through initiatives such as incubators and educational programs.

Many countries, such as Germany, Denmark, Norway and Japan, have recently adopted a Bayh-Dole type of regulation, giving their universities the responsibilities, rights and (occasionally) the resources to patent and license inventions. Universities in these countries do not have the same history of organic experimentation that preceded the enactment of the Bayh-Dole Act in the U.S. There are, however, other important particular experiences to learn from, in which non-U.S. universities have become involved in commodification and realization of knowledge stemming from research. In Sweden, and in particular at Chalmers University of Technology, a tradition of facilitating, developing and eventually investing in new ventures has evolved since the 1960's[5]. This tradition exemplifies the involvement of universities well beyond the stage of the actual research and invention disclosure and into venture creation. This tradition also exemplifies an (engineering) behavior of building value in ventures, which, in some ways, contrasts the U.S. foci on IP marketing and technology brokering.

Today, different universities and countries have taken different paths towards engaging in commodification and commercialization of knowledge. In the U.S., licensing practices at university TTOs are beginning to evolve after 20-25 years of operation since the enactment of the Bayh-Dole Act of 1980. Changes taking place in operative practices may cause a shift in the way TTOs and universities act, in regard to transference of research in the future, perhaps moving away from a strictly licensing structure to a hybrid of licensing/start-up or pure venture creation model. In contrast, Sweden may shortly follow its Nordic counterparts in shifting its regulations regarding university research ownership from individual ownership of IP by the professor/researcher, known as the

[5] For an overview of Swedish research and innovation policy as well as more insights into the Chalmers case please see Jacob, Lundqvist, Hellsmark, 2003, *Entrepreneurial Transformation in the Swedish University System: the case of Chalmers University of Technology.* Research Policy 32, 1555-1568.

teacher's exemption, to university ownership, thus adopting a Bayh-Dole type of regulation. Regulation augmentation will probably have repercussions in the current venture creation/innovation system models that exist at institutions such as Chalmers.

If universities are indeed to walk down paths of commercializing knowledge, there is reason for a search for a "new intellectual infrastructure" of universities, in which the commercial roles and practices of universities converge. Such a new infrastructure could both help to fuel the knowledge economy, while also creating stronger clarity around the social contract of universities. By providing two significantly different case illustrations – Columbia in New York and Chalmers in Sweden – including some converging trends, the paper aims at anchoring universal conceptual elements of such a new university infrastructure, in terms of the roles played and norms applied, and in terms of an object-oriented process of commodifying inventions into IP. In doing so, the paper hopefully invites further constructive exploration towards a new university infrastructure around knowledge commercialization.

The paper is organized as follows: First, the controversial issue of universities increasingly becoming commercial actors is discussed and different arguments are outlined. Next, an intellectual capital perspective of the university and its surrounding economy is introduced to help provide an overarching framework for understanding how commodification and commercialization of knowledge can be carried out within a university platform concerned with open exchange, while still interacting in a market economy. Thereafter, the two cases – Columbia and Chalmers – are presented, while paying respect to both historical and regulatory backgrounds. The analysis explores consistencies, compatibilities and areas of conflict, while applying both a role-oriented and an object-oriented perspective. Finally, implications center on the opportunities and threats that exist when expanding a Bayh-Dole type of regulation beyond U.S. borders. Additional focus is placed on the challenges a new infrastructure requires, in terms of complex interplays and new balancing acts for research groups, university managers and other actors in the transference process.

**Spanning boundaries between open exchange, licensing and venture creation**

Spanning the boundary between open exchange and market transactions is as much a theoretical challenge as a practical one. The concern here is to outline what universities can do on the structural level for increasing *or maximizing* the *responsible* utilization of new knowledge in society under the constraint of preserving the university task of governing open exchange, open science and the *fair* building of recognition capital among its researchers and students. Most universities of the world, except perhaps some so-called corporate universities, are concerned with preserving these "constraints". Even though commercialization efforts may increase in the future, few believe that this should be at the expense of an open exchange model.

However, national regimes, university cultures, as well as managerial practices may differ significantly. To bridge these differences in a way that allows for constructive learning and convergence, a theoretical framework that recognizes different traditions and values, while being sufficiently distinct, is needed. Here the focus will be upon two phenomena: 1) the role (and norms) of the university when managing and investing in both open exchange and IP commercialization, and 2) the object-oriented process, in which new knowledge is packaged into a claimable object (e.g. patentable invention) and further developed into IP, licenses or new ventures.

*Expanding the role of the university*

As indicated in Figures 1 and 2 above, as well as in the reasoning in the previous section, one can apply an "intellectual capital" perspective upon the university and the surrounding economy. More specifically, and in alignment with Bourdieu and others[6], the university world invests in open exchange resulting in knowledge in the public domain and in the building of type of cultural capital, which we label recognition capital, that depends upon a combination of the individual's personal achievements and the individual's adherence to standards set by e.g. universities. With specific rules of conduct on how to publish, acknowledge credit to others, etc., the building of recognition capital

[6] See for instance Bourdieu, P. 1988. *Homo Academicus.* (Stanford: Stanford University Press.) about the building of capital in academic settings and Petrusson, U. 2004. *Intellectual Property Management and Entrepreneurship*, CIP/Göteborg for a comprehensive intellectual capital perspective.

of individuals is enabled. Recognition capital can occasionally be transformed into currency through the individual raising his/her salary, receiving tenure or doing consultancy work. However, it is not normally possible to commercialize the creative achievement (i.e. the published work). On the contrary, by avoiding the issue of "who gets paid for what", certain types of collective open exchange achievements, such as open source software development or mapping the surface of Mars, can be efficiently coordinated, especially now with the help of Internet and modern information and communication technology (ICT)[7].

While investing in open exchange is, and arguably will, remain the key task of universities, there are two other types of investments that can contribute to increasing the financial (or economic) value of new university based knowledge: investment in licensing and investment in venture creation (see Figure 3). Investments in licensing typically focus on the identification of interesting knowledge objects to package into IP and are marketed towards relevant licensees. The role is primarily one of "technology brokering" in which the ability to network and market a technology is critical for success. Venture creation is an alternative way of building capital, in which human creativeness is captured within a venture, allowing initial new knowledge and IP to be complemented with other assets, leveraged into proofs of principles, proofs of concepts, brands, products and/or services.

Bringing these two types of investment processes into the realm of the open exchange university, creates potential tensions and conflicts between all three. The two cases to be explored – Columbia and Chalmers – have primarily integrated licensing and venture creation, respectively, into their roles and "brand image". These universities have a history of responding to external and internal reactions concerning their respective blending of Open Exchange/Licensing and Open Exchange/Venture Creation. Both Columbia and Chalmers, and the types of university structures they represent, are also heading towards the intersection of all three roles, albeit from different points of

[7] Reference here to Stefan Thorpenberg for the linking of open science and open source philosophy in a chapter in a book in progress, edited and coordinated by CIP.

departure. It is in this intersection that a "new intellectual infrastructure" is to be explored.

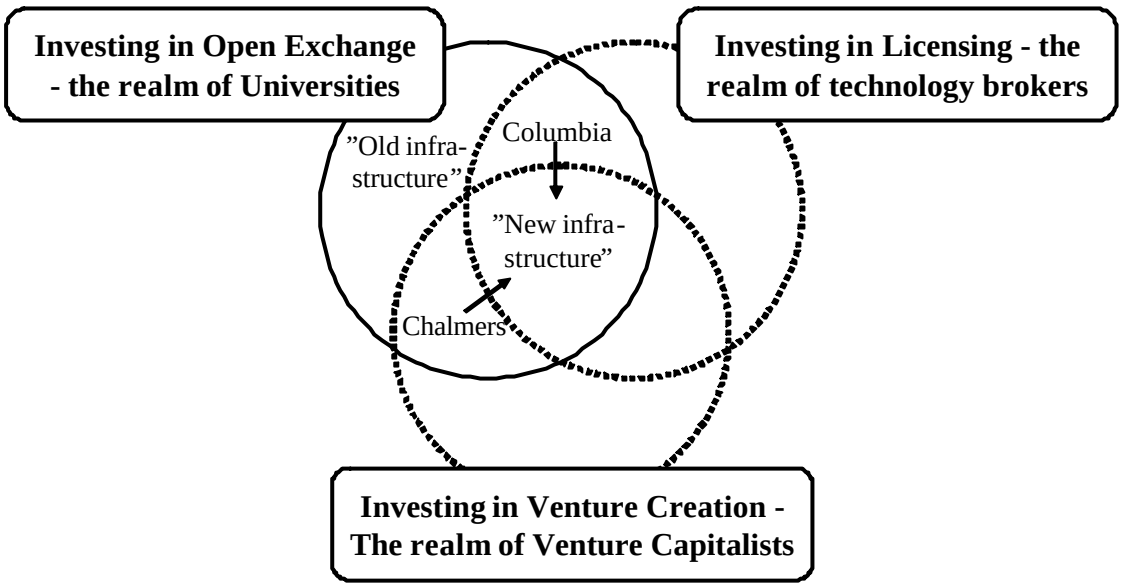


*Figure 3. Universities are expanding a realm of Open Exchange into realms of Licensing and Venture Creation. The two cases – Columbia and Chalmers – operate in two realms and are both heading towards combining three roles.*

An object-oriented perspective focuses on the commodification of knowledge, or – more specifically – on a new knowledge object and how it is identified, claimed, licensed, and/or packaged into a venture (see Figure 4). While an object-oriented perspective is very natural for licensing professionals and researchers operating under a Bayh-Dole type of regulation, it is not obvious for persons operating in the traditional sciences, where open science/exchange and informal collaborations with industry are the norm. From the latter, knowledge is often seen as something relational and occurring in the exchange, rather than as something primarily objectifiable. The issue of objectifying and commodifying knowledge is therefore a debated phenomenon[8]. Arguments on one side state that increased commodification will hinder the efficiency of open exchange research as well as increase barriers of entry for innovations, due to increased costs of licensing to

[8] See e.g. Nelson, R.R., 2003, The Market Economy, and the Scientific Commons*
Richard R., Columbia University working paper, August 11, 2003

actors commercially claiming basic research results. Arguments on the other side state that developments in ICT, making certain knowledge much more codifiable, have irreversibly transformed the process of research from having been more relationship-based to being more object-oriented. The strong link between ICT and biotechnology (DNA is basically information), and the dominant appearance of biotechnology breakthrough patents in license oriented university research, has, according to this argument, made it too late to reverse developments into non-object-oriented research[9].

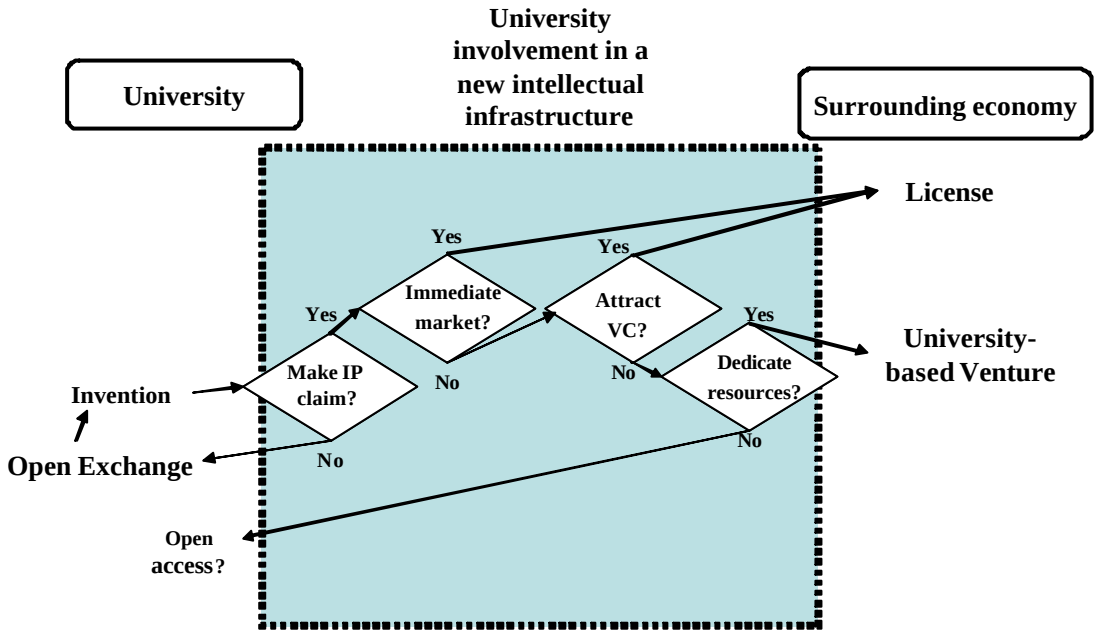


*Figure 4. An object-oriented model of university-involvement including decisions and activities that result in economic value creation through licensing and/or venture creation[10].*

This "defacto" argument allows us to propose the object-oriented choice-model in Figure 4, while returning to this controversy again with "new eyes" in the in the end of the paper. As indicated in Figure 4, the two types of commercial roles to be explored further in the two cases – licensing and venture creation – seem, at least in theory and on a

[9] This paper reflects the interdisciplinary discussions occurring on the CIP Symposium on the "Entrepreneurial University" in June 1-3 2004, in Gothenburg, Sweden (www.cip.chalmers.se), and in a subsequent book-writing process exploring different models of commercializing research.
[10] The model stems from a book writing workshop organized by CIP in New York April 1st 2005. Special reference in this case to Gregory Graff.

surface level, to be possible to combine. Important to note is that there are underlying assumptions behind the proposed model in Figure 4, such as universities owning IP, and universities inviting external engagement prior to investing more of their own resources. Other models, such as transferring IP ownership (rather than licensing) or investing a priori in promising ventures (rather than first inviting external investors) are also possible. The present model, however, conforms to Bayh-Dole regulations and has benefits that will be discussed further after the two case illustrations.

**Universities as licensors – the Columbia example**

For over a decade, Columbia University has been one of the top three universities generating income from commercialization of university developed research. In 1994, Columbia was second only to Stanford in university licensing income, but by 2001 had far surpassed them, in part because of the expiration of one of Stanford's main "blockbuster"[11] patents in 1997 (the Cohen-Boyer patent), and the discovery and filing by Columbia of its own "blockbuster". Indeed, a substantial portion Columbia's commercialization revenue has come from royalties received from licenses of four key patented technologies, called the "Big Four". These four technologies are: 1) Co-Transformation: a genetic engineering process; 2) Xalatan: a glaucoma treatment; 3) Soluble CD4: anti-body technology (together with Stanford University), and 4) MPEG-2: digital compression technology. These technologies, particularly Co-Transformation (likened to Stanford's Cohen-Boyer patent), have been crucial to the external recognition of success of Columbia's technology transfer process, but have also placed the university under scrutiny.

Columbia University is one of the oldest and most prestigious universities in the United States, and includes the earliest established medical faculty in the country[12]. The university comprises of not only a medical school, but also and engineering, law,

[11] Licensed technology that generates substantial royalties.

[12] In fact, the establishment of the medical faculty of the school, eventually to be known as Columbia University, pre-dates the United States as an independent country. Columbia was originally founded in 1754, as King's College under the British Royal Charter, was re-chartered as Columbia College in 1784 after the United States gained its independence, and then was again re-chartered as Columbia University in 1896.

business and liberal arts and sciences, as well as additional specialty graduate schools. In 1928, Columbia developed the first integrated medical research, education and clinical care facility in the United States. Today, the university consists of more than 23,000 students and 3,000 faculty members, with an additional 4,000 researchers/clinicians. The university produces undergraduate, graduate and post-graduate degrees, and has among its accolades, 70 Nobel Prizes, over 500 patents, and an accumulated ½ Billion USD in research support. Thus, the university has substantial resources for the creation of research and intellectual property.

While at the forefront in many areas of academia, Columbia University was late-comer to technology transfer, relative to the other major U.S. research universities. Indeed the earliest TTO was at the University of Wisconsin, prior to WWII, but several other universities began establishing or hiring technology transfer offices in the 1960's and onward. However, some key universities, including Columbia were reluctant to engage in patenting and technology transfer activities, particularly regarding medical research. This is particularly noted in the university regulations that prohibited medical faculty from patenting inventions until 1975. Indeed, Columbia only patented one of its key technologies just prior to the effective date of The Bayh-Dole Act, arguably the most important piece of U.S. legislation pertaining to technology transfer and intellectual property ownership rights.[13]

The Bayh-Dole Act of 1980 came about as result of "…concern, along with growing dissatisfaction within Congress and the industrial community over the lack of uniformity in patent rights to inventions resulting from federally funding research…"[14], and to a great extent was due to the efforts and support of various national organizations of colleges and universities. The Act was established to encourage the utilization of

[13] Mowery, Nelson, Sampat, Zedonis. 2001. *The Growth of Patenting and Licensing by U.S. Universities: An Assessment of the Effects of the Bayh-Dole Act of 1980.* Research Policy 30, 99-119.
[14] Mowery, D. January 2005. *The Bayh-Dole Act and High-Technology Entrepreneurship in U.S. Universities: Chicken, Egg, or Something Else?* Colloquium on Entrepreneurship Education and Technology Transfer. p 11

inventions created and produced under federal funding[15], thus promoting the involvement of universities in the commercialization process. "Before Bayh-Dole, the federal government had accumulated 30,000 patents, of which only 5% had been licensed and even fewer had found their way into commercial products."[16] The policy permits both exclusive licensing and retention of title with transfer of an invention to for-profit agencies, but encourages broader licensing practices, namely non-exclusive, with an emphasis on transference to start-up or small businesses, with the ultimate objective of being maximum benefit to society. The university is given the responsibility to, in a timely manner, identify and transfer technology from within its research departments (this process is often called due diligence), but in turn, is given a reasonable time frame in which to patent the inventions/technology with security of secrecy. The government maintains royalty-free, non-exclusive rights to inventions for government purposes (called march-in rights). The government is also allowed march-in rights if it is deemed that the university is not performing due diligence.[17]

The main financial support for university research comes from U.S. national and regional government funding organizations, namely the National Science Foundation (NSF), along with other national funding organizations[18], as well as state science and research funding organizations, which provide substantial innovation focused funding, including approximately 90% of university research funding. In U.S. university technology transfer, the organizations involved in commercializing knowledge are the universities and colleges, their administrative and academic departments, leadership and members, as well as external suppliers of funding, research and advice. The institutions directly influencing these organizations are mainly government regulations, but also state and

[15] The Bayh-Dole Act plays a significant role in technology transfer at U.S. universities, because the majority of R&D funding, approximately 90%, comes from federal or state or private funding (a small portion of the 90%), with only approximately 10% from industry. As mentioned in Section 3.0, the NSF, DOE, DOD, NASA, and NHHS (in part through SBIR and STTR), are the main funding organizations.
[16] President of the Association of American Universities.
[17] The Bayh-Dole Act: 35 U.S.C. §200-212; 37 C.F.R. Part 401
[18] Along with the NSF, the Dept. of Energy (DOE), the Dept. of Defense (DOD), National Air and Space Assoc. (NASA), and National Health and Human Services Dept (NHHS), through the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, substantiate significant innovation funding. http://www.acq.osd.mil/sadbu/sbir/homepg.htm

local regulations, as well as university rules and norms, and the 'unwritten rules' developed within the cultures of the various research departments of the universities.

At Columbia, the current technology transfer process is carried out by Science and Technology Ventures[19] (S&TV), the commercialization arm of the university. S&TV was founded in 1982 and consists of two facilities in New York City: one at the main campus, adjacent to several of the engineering departments, and one at the medical school campus, in the university hospital facility. S&TV is overseen by an Executive Director, and three managers focused on 1) New Ventures, 2) S&TV Partnerships, and 3) Economic Development. The rest of the organization works in a matrix formation, within the broad areas of either health sciences or general sciences, and focusing on particular research departments. The core of the approximately 30-member staff is made up of Technology Licensing Officers (TLOs).

It is both from within and through this quagmire that innovations must be harvested and pushed to market. Bayh-Dole encourages technology transfer that stimulates or supports new or small businesses. Based on AUTM[20] annual reports from 2001 and 2002, small businesses[21] seemed to have received over 50% (up to 54%) of academic licenses. Start-up firms and firms spun-out specifically to commercialize licensed technology only received approximately 15% of licenses. The remainder (32-33%) went to big business.[22] At Columbia, licensing revenue represented 31% of total income in 2003; this percentage increased to 40% in 2004. If we revisit the "Big Four", we can see not only the substantial returns to the research departments of Columbia, but the significant contributions to the U.S. economy and GDP (Gross Domestic Product) as well as significant, unquantifiable social benefits:

1) Co-Transformation is a recombinant DNA process based from research of Richard Axel, Saul Silverstein, and Michael J. Wigler ~ sometimes called the

[19] Information gathered from research visit to Columbia's S&TV office in December of 2004. www.stv.columbia.edu
[20] Association of University Technology Managers: www.autm.net
[21] Less than 500 employees
[22] Mowery, D. January 2005. *The Bayh-Dole Act and High-Technology Entrepreneurship in U.S. Universities: Chicken, Egg, or Something Else?* Colloquium on Entrepreneurship Education and Technology Transfer. p16.

fourth of the Axel patents (the other three expired in 2000). The patents are valued at over 600 Million USD, though Columbia never earned more than 1% royalty. The patent has helped to make an estimated 60 Billion USD contribution to GDP (economy) and is licensed non-exclusively to more than 30 different (biotech) companies. In 2003, Columbia was sued by three key U.S. biotech companies over the Axel patent, claiming that the university was attempting to create a "patent monopoly". "Many observers of the litigation say the case, extremely unusual within the world of technology transfer, was initiated because of the large sums of money the patent had generated."[23]; money that is transferred directly back to the inventor, research department, school (medical, etc.) and university through a revenue sharing distribution[24].

2) Xalatan is a prostaglandin-based drug (prostrate gland), licensed first to UpJohn and then Pharmacia (now Pfizer), used in the treatment of Glaucoma[25]. It is an example of a technology that had to be licensed to a large company in order to be developed further, because it was mainly the large companies that had also done research in prostrate glands. An excess of 250 Million USD has been earned through licensing, but this income stream will soon come to an end, as the patent will expire shortly.
3) Soluble CD4 is soluble protein developed into an antibody technology used in a prototype for a drug to fight AIDS. This was transferred through an exclusive license to a small biotech company, Centercore, now owned by Johnson & Johnson, and has generated substantial revenue. Technologies are often licensed to small companies that are then bought by larger firms. This process emphasizes the importance of licensing structures that ensure Columbia's royalty percentages are not diluted, i.e. called pass-through royalties in the license.
4) MPEG-2 is the only of the "big four" that is not a bio-based technology. MPEG-2 is digital compression technology, mainly utilized in video technology.

[23] *Biotechs sue Columbia over fourth Axel patent.* Nature Biotechnology, Volume 21, Number 9, Sept. 2003.
[24] If the net revenue is less than 100,000 USD, then 50% goes to the inventor, 25% to the university and 25% to the inventor's research. If the net revenue is greater than 100,000 USD, then 33.33% goes to the university, 25% to the inventor, 25% to the inventor's research, 8.33% to the department that delivered the research, and 8.33% to the school (ex. medical, arts and sciences, engineering, etc.). *From S&TV.*
[25] A disease that affects eyesight and can lead to blindness.

> Columbia's patents are joined together with others into a portfolio of over 700 patents (134 patent families) owned by 25 international companies/organizations, called MPEG-LA[26]. This represents an almost open-source like structure that was established to ensure reasonable and nondiscriminatory access to rights necessary for the standardization of MPEG-2 technology. The license covers products developed from June 1994 and onward.

While S&TV enjoys one of the largest sets of resources for a TTO in the U.S., there is still a general feeling from within that the organization cannot perform optimally due to structural constraints in internal technology transfer policies. For example, a desire for a greater degree of freedom regarding licensing income return, directed into a discretionary seed fund (the amount is currently limited and not substantial enough to support more than one to three new firms per year), could allow for the additional development of commercially viable research. There is also a feeling of an eminent shift in the near future. The majority of the "low hanging fruit"[27] and/or "blockbusters" have been harvested, and the operative definition of licensable technology has changed, in part because external structures (particularly the biotech and pharmaceutical industries) have matured. Furthermore, the license agreements linked to these "blockbusters" are beginning to expire. Revenue must come from other forms of commercialization. University regulations at Columbia disallow the ownership of public stock in start-up companies created out of the university research[28], thus theoretically hindering the "innovation model" and the potential fiscal return. However, this policy is understandable because of the complex and "ethically blurred" direction that it would lead Columbia; i.e. becoming a fund manager or broker on the market, and thus seemingly acting in a capacity apart from the mission and objective of the university.

[26] www.mpegla.com
[27] Technology that is relatively easily licensed or commercialized, and substantiates revenue.
[28] Columbia's policy allows S&TV to have equity ownership in a start-up or spin-out, but only prior or to the moment of the initial public offer. At this point, S&TV must exchange its equity for cash at the IPO market price. Columbia's policy is to prevent S&TV from developing into a fund manager (of equity in start-ups that have gone public).

For Columbia, the objectification of ideas that can be transferred has been the main focus since even before Bayh-Dole was enacted. But, because of the trends listed in the previous paragraph, Columbia is starting to utilize longer-term strategies while maintaining operations that ensure the immediate or short-term benefits that have made it so "successful". Focusing attention on long-term benefits illustrates the importance of the development of networks and communities of practice. This is emphasized within the internal metrics staff identified as keys to future success.

- Individual skill set of TTO personnel, including:
    - Ability to establish and maintain relationships (personable) – sales
    - Analytical, detail oriented
    - Visionary: opportunity/innovation recognition
    - A driver/closer: ability to manage and negotiate deals
- Network connectivity
- Licensing income, research agreements, etc.
- Contribution to GDP
- Long-term strategy
- Degrees of freedom to operate

For Columbia, there is now a convergence towards the importance not only of the objects but also the structures surrounding the objects that can continue to stimulate economic growth even after the transferred objects decrease or lose their value. Because of this, Chalmers School of Entrepreneurship presents and interesting parallel example.

**Universities as venture creators – the Chalmers example**

Chalmers School of Entrepreneurship (CSE), together with other key actors in Chalmers so called innovation system, represents a radical departure from the traditional methods of intellectual ownership and technology transfer commonly found in Sweden, and in many parts of Europe. The responsibility of commercialization is spread beyond the shoulders of one individual (typically the researcher/professor) to a team of venture creators, in a process that emphasizes the entrepreneurial role. Through this process, CSE links entrepreneurial training with applicative transformation and development of research and innovation, founded both within and outside the university, into new

ventures. In less than a decade, CSE has successfully created over 30 companies, employing over 150 individuals and attracted approximately 20 Million USD in venture capital and soft financing. At the same time, the school has also graduated 138 trained entrepreneurs while building relationships with dozens of idea providers within and outside the Chalmers University environment.

The traditional Swedish university environment operates under the regulation of the teachers' exemption. This law gives intellectual property (IP) ownership to the researcher/professor within the university, regardless of where the funding for the research originated, if not otherwise bilaterally agreed. The teachers' exemption was enacted in 1949 and was meant to compensate for the low level of pay available to university professors, by enabling them to seek out substitutive revenue for their human capital. In addition, the exemption was meant to allow for the maximization of scientific benefit through control of research results, thus allowing for additional means of commercialization. This policy structure placed a significant responsibility on the shoulders of the professor/researcher to not only identify research applicable for market activity, but to then also engage in the transference or commodification of that research, either through transactions with other market actors, or through the creation of new firms. While there certainly were individuals willing and able to take on such entrepreneurial roles, the activities mentioned above went against the fundamental desire of the majority of researchers/professors to continue their focus on their research, i.e. to be a "basic researcher".

In the 1960's, an electronics professor at Chalmers University of Technology, started championing the idea of transforming university technology into university spin-offs, thereby pioneering an awareness and positive attitude towards commercialization at the university. However, because of the traditio nal role perception of the "basic researcher", and of the technology transfer policy focus on the individual, innovations developed from within the university have remained an exception to common practice. New developments emerged at Chalmers in the late 1990's, focused on finding new pathways for applicable research to the marketplace, still giving the professor partial ownership and

influence, while also freeing his/her hands of the venture creation operational processes, thus allowing for the practice of basic research.

CSE has had two stages of development and operation since its inception in 1997. Version 1 of CSE (1997-2000) was designed as an educational track for engineering and architecture students beginning their final year at Chalmers. To accomplish the objective of developing entrepreneurs, several innovative steps were taken. The first measure was the design of a special student recruitment process, including written applications, tests and psychological consultants. At the same time, an idea recruitment process was established, in order to select good ideas from research or companies around Chalmers, from which the student teams would develop their businesses. The education and execution of the projects was designed to be carried out in an incubation environment (this later became the business incubator Chalmers Innovation). Finally, course modules were built, basing as much as possible upon the real situations in the projects.

In 1999, the planning of Version 2 of CSE (2000-2004) was initiated. Several components were added. The first of these was the evolving of CSE from a last-year education track for engineering and architecture students, into the Swedish equivalent of a Master of Science in Innovation and Entrepreneurship program, open for students who have reached a bachelor degree level. An Entrepreneurship fund was created, through which CSE started taking an active stake in the innovations projects, while attracting venture capital to the business development. At the same time, strong ties were knit with the new Center for Intellectual Property studies, thereby providing international competence on how to build and secure intellectual assets (i.e. how to build knowledge-based ventures).

The innovation projects at CSE stem from research at Chalmers, from other universities, or from small or large firms. The intellectual property of the project is contractually secured by the CSE Fund, prior to the project start. This procedure prohibits unfruitful negotiations during the project year and establishes “fair play” for all actors. The innovation projects are often early patented or patentable ideas that need the

complementary entrepreneurial driving force to reach the market. The aim is to start a new venture, based upon the ideas created during the project year. Projects today range from research intensive to product sales and end-user driven, with an increased number of projects coming from Gothenburg University as well as from established firms, in the form of corporate spin-outs.

When the CSE was first created, it was expected that approximately one project per year would transform into a start-up company. Results have exceeded these expectations to the extent that, in the second version (from 2000), an average of four companies per year have been started within classes containing approximately 20 students, per year, working in teams of three. The following are three representative companies:

1) Oxeon was founded by CSE in 2002, and is based on patented research into technical textiles, developed at Chalmers University of Technology in the mid 1990s. For several years the inventor attempted to commercialize the research, through, among other things, attracting business angels to invest. In 2002, restart of the project was carried out in collaboration with CSE, in which is the business was focused on a technique for industrializing the manufacture of band-woven composites. Today, the company, among other things, works with Formula 1 car producers.[29]
2) Midorion was founded by CSE in 2003, and is based on a basic breakthrough in nanotechnology research, jointly developed at Chalmers University of Technology and Sahlgrenska Academy (the medical school of Gothenburg). CSE was, at a very early stage of the innovation development engaged together in an interplay with a strong and committed board, the inventor (who in this case joined the company after finishing her PhD) and the team of former students. From this group, Midorion was started, to develop a "sensor on a chip" able to detect single molecules, aiming at drug discovery applications.[30]
3) Lamera was founded by CSE in 2004, and represents technology utilized from outside the university structure. Lamera is based on a patented sandwich material

[29] www.oxeon.se
[30] www.midorion.com

> that had been researched and developed at length within the Volvo Corporation. After difficulties in commercializing the new high-performance material towards, primarily, vehicle-applications, Volvo Technology Transfer contacted CSE to make a final attempt at finding new applications. The joint venture between CSE, Volvo and the students also serves as an example of CSE collaboration being an option for developing non-core business technologies from established firms. The material is now initially commercialized towards non-vehicle applications, e.g. bicycle helmets, where establishment barriers are lower and margins are expected to be higher.[31]

Not only have multiple companies been created while within the university structure, but students also continued engage in start-up opportunities after the graduation period. More than half of the alumni remain in the start-up environment. Students also pursue careers as business developers in large firms (approximately 20%), as business development consultants (approx. 10%), as service providers or in research (approx. 10%).

As identified above, the process of identifying success is twofold, and represents the initiated convergence towards value creation in the new intellectual infrastructure. The foremost objective has been and continues to be the development of human capital, represented in the education and dispersion of entrepreneurial leaders into society. These educational pursuits can be measured by:

- Development of skills and tools
- Network connectivity
- Timely opportunity recognition, including quantification and valuation of project applications
- Capability to balance risk and ambiguity

However, the development of the entrepreneur does not end with the student, but is also established through the connections with researchers, professors, and/or idea providers, that exist both within and outside the university structures. These individuals experience a less concrete, but longer-term engagement in the entrepreneurial learning process. The

[31] www.lamera.se

secondary objective of CSE is the practical application of ideas harvested from researchers, professors, and idea providers, and coupled together with the students into the creation of venture firms. This represents the importance of commodification of human capital into structures that hold market recognition; the formation and operation of companies. For the creation of new ventures, success measurement must be applied to both the pre-incubation CSE program as well as the additional stages of Chalmers innovation system. Criteria include:

- Capture of intellectual capital into structural capital
    - Including company formation
- Valuation and value recognition by the market (external financing)
- Employment
- Turnover

The metrics presented attempt to meet multiple and, at times, divergent objectives, which limits the obtainable measurements. These limitations emphasize the need for collaborative activity and illustrate why there is beginning to be a convergence towards a new territory, in which these divergent objectives are more closely aligned.

**Analyzing the cases**

This section comprises an analysis of lessons learned from the cases, including an understanding in the differences of approaches, of any converging trends, as well as a discussion of the challenges that maybe faced when choosing one path or the other.

Lessons learned from Columbia

Columbia developed a successful and lucrative licensing process in a relatively short period of time, 15 years, mainly based on the opportunities presented by the Bayh-Dole Act; and without a pre-established history of organic entrepreneurial activities, such as those that existed at Stanford and MIT, prior to Bayh-Dole. It is therefore relatively safe to conclude that the enactment of Bayh-Dole, gave Columbia an “immediate” market presence and market power, which were critical in accomplishing successful licensing agreements. Universities in non-Bayh-Dole environments and in environments with less

coordinated federal public research spending are arguably having a tougher time in gaining such market acceptance and market power.

In the Columbia case, it is also important to note the strong history of an interdisciplinary organized medical school, which has likely been critical in developing key inventions, readily exploitable through licensing. This collaboration has helped to establish synergies that have likely been crucial to the generation of three "blockbuster" biotech licenses, and not just one, which could have been regarded as luck or an anomaly.. However, the backing from favorable regulations and a strong interdisciplinary research tradition do not fully explain the Columbia phenomenon. Sophisticated commercial collaborative arrangements also need to be recognized. Two successful examples signify this aspect: the MPEG-2 patents being pooled into the MPEG-LA construction, and the collaboration with a key industrial actor for development of the glaucoma drug.

Comparing Columbia with the "ideal model" in Figure 4, an inclination towards packaging as many inventions as possible into license agreements can be found (see Figure 5). Columbia expresses a strong desire and trend towards greater involvement into later venture creation stages, but such activities would require more revenues being invested. The financial success of Columbia licensing, might have overshadowed the potential that the licensing approach also has in promoting public interests, such as regional growth, maximizing constructive utilization of knowledge, increasing public health, etc. The licenses issued by Columbia, (and most certainly by many other U.S. universities), do actually allow such interests to be governed, though this is often neglected when focusing on university revenues from licensing. This effect – i.e. to impose public interests through the licensing tool – needs to be seen as part of the Bayh-Dole stipulated licensing model, and would be lost if universities, instead of licensing, transferred ownership rights to private interests, or only were interested in governing minority equity positions in ventures. The latter models would only be revenue-generating for universities, not allowing the university to remain responsible for how new knowledge is utilized in society.

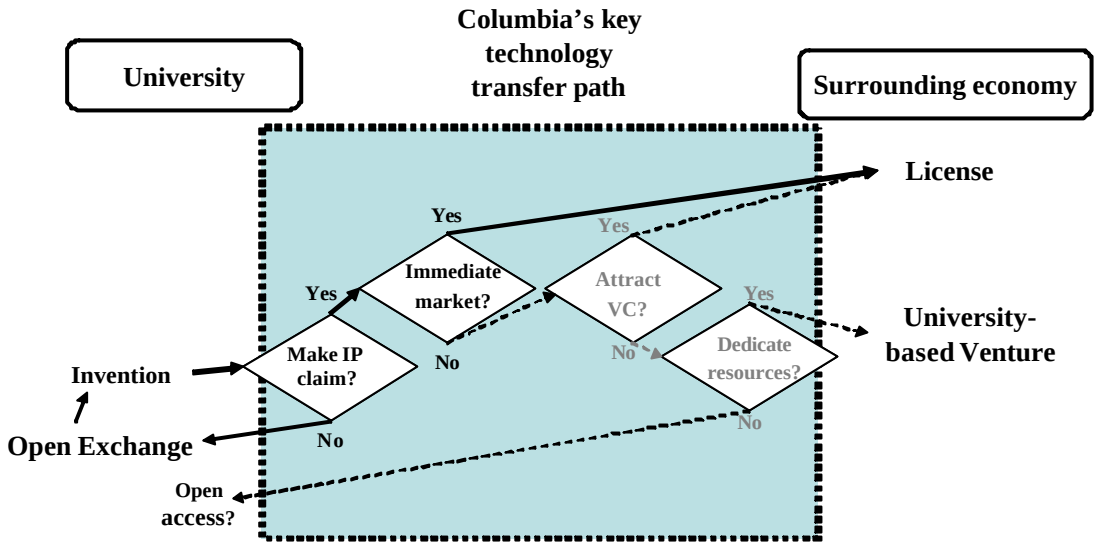


*Figure 5. The key path for technology transfer at Columbia, as compared with the reference model in Figure 4.*

*Lessons learned from Chalmers*

Chalmers School of Entrepreneurship represents an institution that holds a legitimacy and acceptance of entrepreneurial activity, based on a long history of championing such efforts from within the university, then coupled together with the proactive innovation measures adopted in the early 1990's. These activities are perhaps most readily seen in the facilitation of down-stream activities, mainly focusing on spin-outs and new venture creation. Chalmers and the surrounding society has learned the importance of CSE being involved in down-stream venture creation, not because of large revenue streams – they are yet to be proven – but because of the societal recognition and relevance such involvement is given in comparison to traditional research. Hence, a small investment per year in venture creation, as compared to Chalmers overall budget, results in a profiling of and strategic marketing of Chalmers in society. As a potential bonus, on top of this, remains potential revenue from equity positions.

Another significant lesson from the CSE case is the development of human capital along with the development of IP. This synergy can both be seen as a conscious risk strategy – i.e. students get a grade even if a project fails, and therefore also "high-hanging fruits" are pursued – and as a way of consciously developing more entrepreneurial professional

roles. The CSE model enables for scientists, students and collaborative partners to demonstrate and prove entrepreneurial skills. The recognition capital gained through learning and applying established norms of a profession is thus expanded into also encompassing entrepreneurial dimensions, whether that of being a scientist spending "extraordinary efforts" on validating a technology, or as a student building an entrepreneurial track-record, beyond expectations of the curricula[32].

Thus, through the entrepreneurial role emphasis, in which the object oriented approach in Figure 4 is more implicit, CSE's objective is in capturing the human that holds the capital and teaching that human how to not only commodify their own knowledge, but also identify and commodify the human capital of others into products and into a venture that can evolve beyond the initially identified idea (see Figure 6). However, this human capital focus also points to a problem in the current CSE model. The lack of regulations and policies around a disclosure procedure and how proper ownership of university-based inventions should be established, also creates complex situations, in which degunkification of IP claims needs to be carried out in parallel with identification and development of commercial claims. As a result the CSE model invests first in the relationship with a potential inventor, and thereafter looks into all the relevant issues in developing "the object". All these special aspects are captured in the adapted object- and human capital oriented model in Figure 6. Several decades of relatively little spontaneous venture creation and lack of a boundary-spanning (university-business boundary) entrepreneurial activity helps to motivate the relevance for such a model. However, in a more regulated Bayh-Dole type of environment, opportunities for a more systematic and efficient step by step validation of commercial potential could probably be pursued.

[32] Lundqvist, M.A., 2004, *Entrepreneurial roles in the university*, paper presented at the CIP symposium on "The Entrepreneurial University", June 1-3, in Gothenburg.

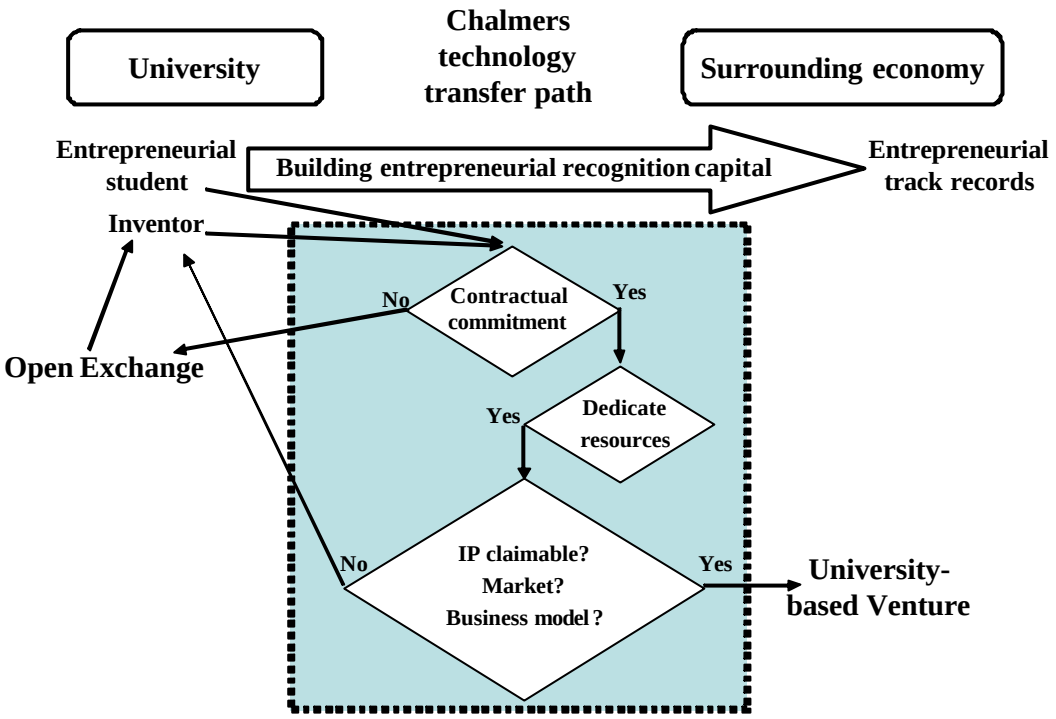


*Figure 6. The Chalmers (CSE) model, focusing on contractually committing inventors before dedicating resource in a collaborative process of investigating the potential for a new venture.*

*Converging trends*

Columbia is now engaging in more and more start-up and spin-off activity, with an increasing aspiration for self-funding of certain projects. There is also increased incorporation of students into the opportunity recognition process. CSE is recognizing the need for increased analysis of inventions and innovations received as potential projects, and being able to apply a licensing component in the commercialization of such projects. As indicated in Figure 6, the open exchange model of building recognition capital can be extended to include entrepreneurial value creation in establishment of networks, collaborations, relationships, and ventures. This includes the recognition of new types of roles, developed within the university and then transferred outside the universities: the academic entrepreneur, evolving from the university scientist or researcher actively engaging in the formation of innovation through licensing and technology development; the start-up entrepreneur, evolving from the student educated in not only the theory of

entrepreneurial activity, but now actively partaking in venture creation and licensing of new ideas while within the realm of the university; and the institutional entrepreneur, evolving from the consultative or otherwise administrative actor that has the ability to facilitate opportunity recognition activities, learning and guiding the other two entrepreneurial roles through the process[33]. We propose this entrepreneurial recognition capital model combined with the object-oriented licensing-based step-by-step model introduced as an image of what a new university infrastructure for commercializing new knowledge could comprise (see Figure 7).

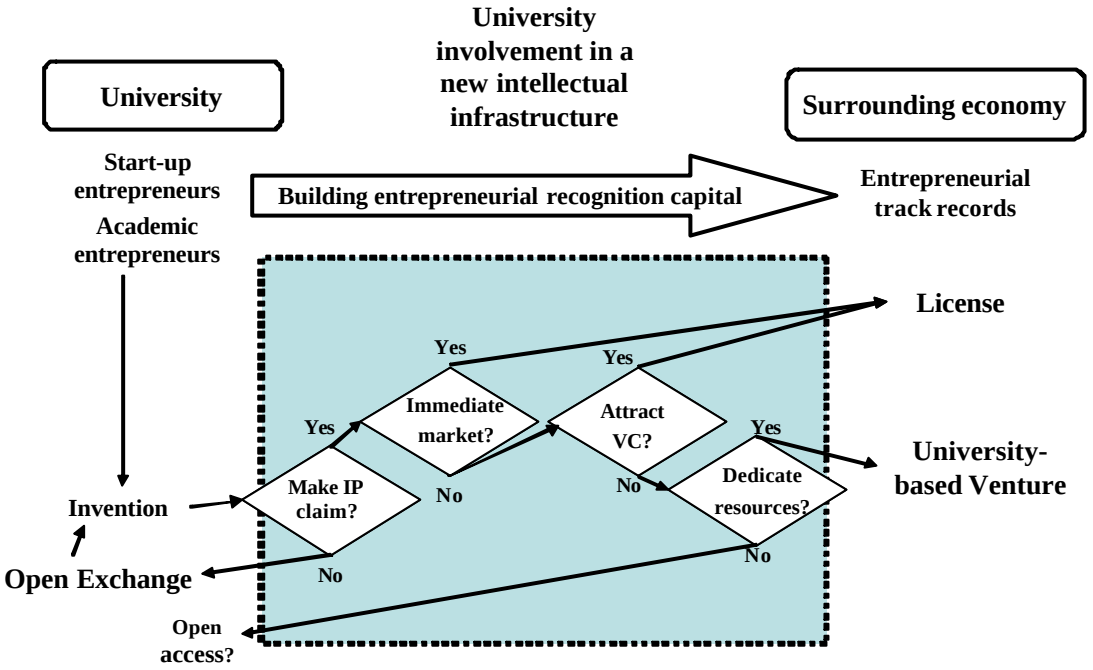


*Figure 7. The proposed model of a new infrastructure for commercializing knowledge by combining a step-by-step object-oriented approach with the building of entrepreneurial recognition capital.*

## Implications and discussion

Both case examples can be seen as pioneering efforts in the area of university commercialization. Both cases now face a much broader inclusion of all relevant actors in learning processes – professors, students, business people and policy makers. When this

[33] Lundqvist, M.A., 2004. *Entrepreneurial roles in the university*, paper presented at the CIP symposium on "The Entrepreneurial University", June 1-3, in Gothenburg.

happens, university management is likely to confront a need of change in leadership style, from a more reactive governance of open exchange and nurturing diversity, to a more proactive, prioritizing and strategic leadership. Central to this change is finding ways to develop such a leadership, without compromising open exchange, and critical as well as "blue sky" research. Most likely, university managers will depend on integrative activity with both government policy-makers as well as on an increased maturity and willingness to flexibly manage the new complex landscape – including critical research, contract research, collaborations, licensing and venture creation – among researchers and research groups. This change-challenge is likely a global concern, and governments and universities need to find ways of supporting step-by-step change, recognizing specific starting points of universities (see Figure 3). The two case illustrations have shown two paths of change towards seemingly converging ambitions. There are most likely other paths as well. However, research, university management and policy-makers needs to discuss 1) how a new infrastructure for commercializing can be conceptualized and 2) what different paths to reach such an infrastructure are required in terms of coordinated policy-practice-theory interaction.

**References**

*Biotechs sue Columbia over fourth Axel patent*. Nature Biotechnology, Volume 21, Number 9, Sept. 2003.

Bourdieu, P. 1988. *Homo Academicus* (P. Collier, Trans.). Stanford: Stanford University Press. (Original work published 1984)

Etzkowitz, Henry. 2002. *MIT and the Rise of Entrepreneurial Science,* Routledge, London.

Jacob, Lundqvist, Hellsmark. 2003. *Entrepreneurial Transformation in the Swedish University System: the case of Chalmers University of Technology.* Research Policy 32, 1555-1568.

Lundqvist, M.A. 2004. *Entrepreneurial roles in the university*, paper presented at the CIP symposium on "The Entrepreneurial University", June 1-3, in Gothenburg, Sweden.

Mowery, David C. January 2005. *The Bayh-Dole Act and High-Technology Entrepreneurship in U.S. Universities: Chicken, Egg, or Something Else?* Colloquium on Entrepreneurship Education and Technology Transfer.

Mowery, Nelson, Sampat, Zedonis. 2001. *The Growth of Patenting and Licensing by U.S. Universities: An Assessment of the Effects of the Bayh-Dole Act of 1980.* Research Policy 30, 99-119.

Nelson, Richard R. August 11, 2003. *The Market Economy, and the Scientific Commons.* Columbia University working paper.

Petrusson, Ulf. 2004. *Intellectual Property Management and Entrepreneurship*. The CIP Series.

Saxenian, Annelee. 1994. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge Harvard University Press

Tornatzky, L.G., Wauga man, P.G., and Gray, D.O. 2002. *Innovation U: New University Roles in the Knowledge Economy,* Research Triangle Park, N.C.: Southern Growth Policies Board.