UNIVERSITIES, INTELLECTUAL PROPERTY RIGHTS AND SPINOFFS: A CRITICAL EVALUATION

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Introduction

The efforts in protecting the intangible property of the intellectual mind in its any form, be it patent or copyright or trademark or designs is at its peak in contemporary times. In this particular context, it is pertinent to understand the role of universities as major contributors of scientific research leading to invention and innovation in the world. Universities not only prepare the labor force in fact they create the much needed skilled human resource. As a matter of fact, it is universities that explore new areas, push the frontiers of knowledge into the future and more often than not lay the foundation for new industries. Therefore, it is important to understand the linkage between Universities and the production of knowledge not only historically but also in contemporary times. This paper aims to look into the university research system in relation with intellectual property rights. We would also make an attempt to explore the technology commercialization of university research in Canada, Japan and India and try to understand the meaning and role of Technology Transfer/Licensing Office in this regard. Though universities can adopt several methods of commercializing developed technologies, our focus is on creation of university spinoffs through the commercialization of research in these three countries. Hence, the paper also aims to look into the various models of spinoff creation in universities, analyze them and understand the nuances that they consist of.

Universities and Knowledge Production: Historical Backdrop

Since ancient times, India has had a very robust tradition of higher education. This is evident from the centers of learning which existed in the 7th century BC in the form of the Buddhist monasteries and in the 3rd century AD at Nalanda. With students and scholars from Korea, Japan, China, Tibet, Indonesia, Persia and Turkey, the major areas of learning at Nalanda were Buddhist studies, fine arts, medicine,

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mathematics, astronomy, politics and the art of war.[1] In the European context, the first so called university originated in the form of a medical school at Salerno, Italy in the 9th Century. In the true sense though, the first university originated at Bologna. The first university to be established in northern Europe was the University of Paris, established sometime between 1150 – 1170 A.D. The University of Oxford, founded in the 12th Century was the most reputed in England. Major part of the curriculum consisted of the seven liberal arts namely; grammar, logic, rhetoric, geometry, arithmetic, astronomy and music. The universities in the 12th till 14th Century were although controlled by the state, they drew their powers from the church.[2] Their autonomy from local government control, in other words, depended upon their subordination to the community of God. In keeping with the Christian order of truth, knowledge was constructed as eternal and scholarship as a matter of interpretation, imitation, and cultivation. During the Reformation, in the 16th century, many universities were freed from the direct control of the Church and came under secular state supervision. In the process, they lost their monopoly over knowledge and science.[3]

As authority was vested in individual genius and the scientific method, "true knowledge" moved from the academy to scientific societies. The academy still had the power to license professionals, but it could no longer claim to license "knowledge" in the sense of "that which is worth knowing".[4] Although till most of the 17th Century, both Protestants and Catholic universities staunchly defended religious doctrines and were averse to the rapidly increasing influence of science which was gaining ground in Europe, the first modern university of

1 Nalanda was established in the 5th century AD in Bihar, India. Founded in 427 in northeastern India, not far from what is today the southern border of Nepal, it survived until 1197. Nalanda's main importance comes from its Buddhist roots as a center of learning. Hsuan Tsang, the famous pilgrim from China came here and studied and taught for 5 years in the 7th Century A.D. Nalanda University at that time had over 10,000 students and 3,000 teachers. For some 700 years, between the 5th and 12th Centuries, Nalanda was the center of scholarship and Buddhist studies in the ancient world. A great fire wiped out the library of over 9 million manuscripts and at the beginning of the 12th Century, the Muslim invader Bakhtiyar Khalji sacked the university. It was in the 1860's that the great archeologist Alexander Cunningham identified the site as the Nalanda University and in 1915-1916 the Archeological Survey of India began excavations of the site.

2 Marlon B. Ross: Authority and authenticity: Scribbling authors and the genius of print in eighteenth century England, in Woodmansee and Jaszi, (eds.), The universities of Europe, 1100–1914, Associated University Presses, London, 1994, pg. 235

3 Hilde de Ridder-Symoens: A History of the University in Europe, Vol. 2: Universities in Modern Europe, Cambridge University Press, Cambridge, 1996, pg. 246

4 Marlon B. Ross: Authority and authenticity: Scribbling authors and the genius of print in eighteenth century England, in Woodmansee and Jaszi, (eds.), The universities of Europe, 1100–1914, Associated University Presses, London, 1994, pg. 236

Halle, was founded by Lutherans in 1694. Its modernity was evident as it was the first university to challenge the age old belief system and encouraged reason and inquiry based education.[5]

According to Bruno Latour, the task of the seventeenth century was "the conjoined invention of scientific facts and citizens".[6] Two hundred years later the reproduction of this conjoined invention became the task of the modern research university. Between 1830 and 1920 the university would be thoroughly enlisted in the central modernist project: the scientific construction of, to borrow from Sheldon Rothblatt, a "character who [could] transcend himself," meaning a sovereign subject who could abstract himself from particular circumstance through the use of disinterested reason.[7] During this period, a new proposition of the meaning of university was forwarded by Immanuel Kant. He positioned the university as the embodiment of "thought as action toward an ideal"—the ideal being the production of a national culture and a reasoning subject to serve as its vehicle. He also argued that universities should examine and guide the "inmost thoughts," the "secret intentions," the conduct, and the health of the citizenry through pure disinterested reason. Reason, Kant proposed, was self-justifying; and no one had to confirm it. The principle of reason, in turn, could be deployed to produce men trained in a *method* of knowledge production (the scientific method) rather than a specific body of knowledge. Readings argued that "educated properly, the subject learns the rules of thought . . . so that thought and knowledge acquisition becomes a freely autonomous activity, part of the subject".[8] Its autonomy was founded instead upon reason, the faculty that justifies itself. Only reason can critique reason, so no outside body, including the state, could possibly judge the university. "It is absolutely essential that the learned community contain a faculty that . . . having no commands to give, is free to evaluate everything".[9] Kant, citing the medieval guild rights of the university masters, noted

5 Harold Perkin: History of universities in: Forest, James and Altbach, P. (eds) International Handbook of Higher Education, Springer, Dordrecht, Netherlands, 2006, pp. 176

6 Bruno Latour: We Have Never Been Modern, translated by Catherine Porter, Harvard University Press, 1993, pg. 33

7 Sheldon Rothblatt and Bjorn Wittrock:The European and American university since 1800: Historical and sociological essays, Cambridge University Press, Cambridge, 1993, pg. 30

8 Bill Readings: The University in Ruins, Harvard University Press, Cambridge, Massachuset, 1996, pg. 67

9 Immanuel Kant: The Conflict of the Faculties (1794), Translated by Mary J. Gregor, Abaris Books, New York, reprinted in 1979, pg. 27

that only the university had the right to "create doctors," that is, to certify scholarship and none else.

Thus reconceived, the university was uniquely positioned as the home for, and producer of, "basic" research ostensibly shielded from the operations of power.[10] With this it became possible to say that "the concept of being scientific . . . [gave] the university its internal intellectual coherence," moreover, the university could at last take its place as the central institution of the public domain.[11] It was not the only such institution, of course, since intellectual and cultural resources were not confined to the university sphere. However, the university was a space where the public domain was supposed to be actively and continuously produced. Art, music, and literature, by contrast, transformed common resources into privately owned expression, moving signs and symbols from the public to the private and, once terms of protection had expired, back again to the public domain. University research was similarly engaged in transformation of the common (nature) into the specific (facts about nature), but academic expression was figured as permanently public by definition. If that expression was to claim the status of fact it could not be anything else.[12]

Yet the university was located in a rather peculiar position with respect to the public/private divide. The philosophy faculty, Kant argued, had to be free from government control with regard to its content if it was to be a space where reason was "authorized to speak out publicly".[13] Endowed with academic freedom and corporate liberty, the university was a kind of corporate person with specific rights as against the state. Philosophers also had to be free from the private sphere, for pure rational knowledge could not be limited to the realm of self-interest. The university founded on reason was thus conceptually autonomous from both state and capital. At the same time, the university was the servant of

10 Jacques Derrida: The Principle of Reason: The University in the Eyes of its Pupils, Diacritics, The John Hopkins University Press, Vol. 13, 1983. pg. 11

11 Wilhelm Schmidt-Biggeman: New Structures of Knowledge in Supra note 3 at pg. 489

12 Biagioli, M: The Instability of Authorship: Credit and Responsibility in Contemporary Biomedicine, The Journal of the Federation of American Societies for Experimental Biology, Harvard University Press, Vol. 12, 1998, pg. 6

13 Immanuel Kant: The Conflict of the Faculties (1794), Translated by Mary J. Gregor, Abaris Books, New York, reprinted in 1979, pg. 29

the state, earning its protection by encouraging "the rule of reason in public life".[14]

Further, the university was the servant of capital, legitimating the commodification of knowledge through the construction of the uncommodifiable. Indeed, the status that the university gained from its position in the public domain was precisely what would ultimately make it useful to capital. A permanent space of non-property was created, a "knowledge commons" that could legitimate private property in expression and invention—remembering that the (re)creation of a private domain of intangibles was and is justified by the existence of a public domain— and provide new exploitable resources.[15]

Today research has become an important function of the university system although its roots can be traced back to the beginning of the 19th century in Germany where the University of Berlin came into existence with scientific research at its core.[16] In the following centuries till date, research is of ultimate importance for all universities as the status of universities is based on the research quality and productivity. Many authors have defined research in many ways as regards to the discipline and form in question. Research is primarily defined in different ways by various disciplines and can take many forms. A broad definition of research is given by Martin Shuttle worth, who wrote that "in the broadest sense of the word, the definition of research includes any gathering of data, information and facts for the advancement of knowledge."[17]Another definition of research is given by Creswell, who stated that "research is a process of steps used to collect and analyze information to increase our understanding of a topic or issue". It consists of three steps: pose a question, collect data to answer the question, and present an answer to the question.[18]

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14 Bill Readings: The University in Ruins, Harvard University Press, Cambridge, Massachuset, 1996, pg. 58

15 Biagioli, M: The Instability of Authorship: Credit and Responsibility in Contemporary Biomedicine, The Journal of the Federation of American Societies for Experimental Biology, Harvard University Press, Vol. 12, 1998, pg. 8

16 Joseph Ben-David and Zloczower Awraham: Universities and Academic Systems in Modern Societies, European Journal of Sociology, Cambridge University Press, Vol. 3, 1962, pg. 63

17 Martyn Shuttleworth: Definition of Research, Experiment Resources, Experiment-Research.com. http://www.experiment-resources.com/definition-of-research.html 2008, Retrieved 15th July 2012.

18 John W. Creswell: Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research, Pearson Merrill Prentice Hall, Upper Saddle River, New Jersey, 4th edition, 2011, pg. 132

Research universities are at the zenith of the university system. They serve only the crème of the students and are very few in number.[19] The aim of these universities is to bring research to the core of the university system and apply that research to national economic development. It all started in the later part of the 19th century with the onset of the American Land Grant universities which included direct service to society mainly in agriculture and industry to the objectives of research universities. This brought universities to the limelight and since then universities have been contributing to the society more directly through research and development in almost all countries worldwide.[20]

The University Research System

Over a period of time, universities world over have developed indigenous science and technology system. The science and technology system comprises of resources available to the university like finance, governance or administrative, human, intellectual, and physical capital that acts as inputs to the productivity through research, education, training, and socialization generating intellectual and human outputs. As discussed, the system comprises of[21]:

i. ***Human Capital*:** Faculty, Researchers, Students, Administrators, Technicians etc;
ii. ***Governance Capital:*** Rules, Norms, Policies;
iii. ***Physical Capital:*** Land, Facilities and Equipment;
iv. ***Intellectual Capital*:** Knowledge, Information, and Ideas; and
v. ***Financial Capital:*** Research Grant, Funding etc.

Each of these resources is integral to the system. It is interesting to note that the combination in which these resources are put together and the derived behavior of that combination differs from university to university. The elements of this system, combined within a university structure, together act as valuable inputs in reaching the desired goals of universities like facilitation of research, dissemination of knowledge

19 Burton R Clark: Places of Inquiry: Research and Advanced Education in Modern Universities, University of California Press, Berkeley, California, 1995, pg. 159 & Philip G. Altbach, and Jorge Balán: World Class Worldwide: Transforming Research Universities in Asia and Latin America, Johns Hopkins University Press, Baltimore, Maryland, 2007, pg. 18

20 Philip G Altbach: The Complex Roles of Universities in the Period of Globalization, in Higher Education: New Challenges and Emerging Roles for Human and Social Development, Higher Education in the World, Vol. 3, Palgrave Macmillan, 2008, pg. 6

21 Brett M. Frischmann: The Pull of Patents, The Berkeley Electronic Press, Berkeley, 2005, pg. 8

through education, imparting training and acting for the betterment of the society at large.

University science and technology research systems, like any other system, are invaluable to the society because of the economic activity they generate in addition to the knowledge base that they create for the society. In fact the contributions of the research systems are in the value that is imbibed in final output.[22] The research results produced by these systems mostly contribute to industrial and social needs by facilitating the production of various private or public goods. The results derived from research not only various in specifications but also in terms of its use and application to reach desired outcomes towards the benefit of the society.[23]

Allocation of the infrastructural capital of the universities is not a conscious decision to exploit the market potential of research results.[24] Therefore, the majority of the research and development activities resulting in results have not been towards market oriented research. Of course, this is not to say that university research systems have not contributed by way of conducting commercial research or that research results have never been used commercially but rather that this area has not been an area of priority to the universities.[25] Historically speaking, as regards to the industry or its need in terms of industry orientation, universities have not allocated enough resources. But the trends are changing with changing times.

In the same way, for a good part of the last century public funding for research in universities have not been towards finding solutions for specific problems of the commercial segment of the

22 Brett M. Frischmann: An Economic Theory of Infrastructure and Commons Management, Minnesota Law Review, University of Minnesota, Vol. 89, 2005, pg. 935

23 J. H. Reichman & Paul F. Uhlir: A Contractually Reconstructed Research Commons for Scientific Data in a Highly Protectionist Intellectual Property Environment, Law & Contemporary Problems, Duke University, Vol. 66, 2003, pg. 327

24 Philip E Auerswald,.& Lewis M. Branscomb: Start-ups and Spin-offs: Collective Entrepreneurship between Invention and Innovation, in The Emergence of Entrepreneurship Policy: Governance, Start-Ups, and Growth in the Knowledge Economy, David Hart, ed., Cambridge University Press, Cambridge, 2003, pg. 79-80.

25 Rebecca Henderson, Adam B. Jaffe, and Manuel Trajtenberg: Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965-1988, Review of Economics and Statistics, MIT Press, Vol. 80, 1996, pg. 119

society.[26] Again, this is not to say that public funding has not produced any commercially applicable results but as the historical developments of the Bayh-Dole Act reflects; [27] not only research in this area was insufficient but was also underutilized.[28] Lack of genuine interest of the universities in commercial research outputs and the industry demand for university generated research has been areas demanding a relook at intellectual property. To solve the problems of insufficient research and underutilization of research results by the industry, a re-look at the age old concept of production and utilization of intellectual property was required.[29]

Justifications of Intellectual Property Rights in Universities

It is beyond doubt that universities play a very important role in producing and disseminating new knowledge not only at the regional but also at the national and the global level. This is the reason why many believe that proper mechanisms should be set up to facilitate the transfer of knowledge from universities to the economy effectively and to that extent appropriate policies should be developed. These new developments providing for a more extended use of knowledge or intellectual property developed in universities also provide new justifications than the ones before which was primarily to provide incentives to generate private investments for production of intellectual property.[30]

Firstly, it is commonly held that along with a strong system to protect intellectual property comes strong incentives' influencing the disclosure of new knowledge and ideas though publications, patents, copyrights etc. Especially patents can be a source of technological

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26 Donna Fossum, Lawrence S. Painter, Elisa Eiseman, Emile Ettedgui and David M. Adamson: Vital Assets: Federal Investment In Research And Development at the Nation's Universities and Colleges, published by Rand, Santa Monica, California, Issue 1824, 2004, pg. 2

27 David C. Mowery, Richard R. Nelson, Bhaven N. Sampat and Arvids A. Ziedonis: Ivory Tower and Industrial Innovation: University-Industry Technology Transfer Before and After the Bayh-Dole Act, Stanford Business Books, Palo Alto, 2004, pg. 39

28 Rebecca S. Eisenberg: Technology Transfer and the Genome Project: Problems with Patenting Research Tools, RISK: Health, Safety & Environment, United States, Vol. 5, 1994, pg. 163

29 Kieff, F. Scott: Property Rights and Property Rules for Commercializing Inventions, Minnesota Law Review, University of Minnesota, Vol. 85, 2001, pg. 697

30 Partha Dasgupta and Paul A. David: Toward a New Economics of Science, Research Policy, Vol. 23, 1994, pg. 496 & Paul A. David and Trond E. Olsen: Technology Adoption, Learning Spillovers, and the Optimal Duration of Patent-Based Monopolies, International Journal of Industrial Organization, Vol. 10, 1992, pg. 527

knowledge which many can adopt to their own in order to create or facilitate further knowledge. That knowledge of course cannot be used commercially. This possibility of this produced knowledge not being able to be used commercially by another provides an incentive to the inventor and induces them in disclosing that knowledge rather than keeping it secret.[31]

Secondly, since intellectual properties rights include the right to exclusion they provide the creator or the inventor control of their invention. This right also provides the inventors with an incentive to trade their inventions and innovations as they have the potential to create increasing returns to scale and therefore are much sought after. As the market for these inventions or innovations expand, it automatically results in increasing profits for the inventors.[32] This expansion of the market eventually leads to the proliferation of the produced knowledge, which probably would not have happened in the absence of a proper intellectual property protection system. Similarly, this trade creates a positive impact for the economy via the information spillover effect which are externalities of economic activity or processes that affect those who are not directly involved.[33]

Thirdly, arguments have been put forward that universities might proactively pursue commercializing their intellectual property and contributing to the overall economic growth if they can generate income from it which is pivotal at this time of gradually decreasing public funding for research and development activities at the universities. An enhanced system of protecting intellectual property rights coupled with the reasons mentioned above encourage universities to create intellectual products that are more applied in nature and are suited towards the industry or even spinoffs from universities to either develop or create solutions for the market.[34]

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31 Birgitte Andersen: If Intellectual Property Rights is the Answer, What is the Question? Economics of Innovation and New Technology, Routledge, part of the Taylor & Francis Group, Vol. 13, 2004, pg. 427

32 Luis A. Rivera-Batiz and Paul M. Romer: Economic Integration and Endogenous Growth, The Quarterly Journal of Economics, Harvard University, Vol. 106, 1991, 542

33 Supra note 30 at 537

34 Rebecca Eisenberg: Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research, Virginia Law Review, University of Virginia, Vol. 82, 1996, pg. 1689 & Elizabeth Popp Berman: Why did Universities Start Patenting? Institution-Building and the Road to the Bayh-Dole Act, Social Studies of Science, Sage Publications, Vol. 38, 2008, pg. 860.

Primarily, the above mentioned reasons are responsible for the policy formulations that aim to direct and strengthen the transfer of university created intellectual properties to the industry.[35] The first such policies that became an Act of the legislature was The Bayh-Dole Act of the United States of America which came into existence in 1980 and provided American universities with the desired control over the intellectual properties produced by them by using federal funds and in addition to that it also promoted using the formal protection mechanism for those inventions or innovations by way of patents.[36] As of today, the Bayh Dole Act is known to provide the best economic incentive for companies to pursue further development and commercialization of government sponsored research and development.[37]

It is also true that patents facilitate inventors to allocate necessary resources in research and development activities that result in more innovations.[38] These patents also help the owner or the licensee to utilize such technologies which otherwise would have been hidden away to produce the best results or solutions for the market. These licenses make possible standardization and compatibility among technologies[39] as they can be incremental or even subsidiary to the central technology in use. They also establish business relations and help them develop by patent exchanges resulting in knowledge spillovers.[40] The impact that patents have on competition is also pertinent as they can provide competitive advantage to the holder or help the holder in producing new or differentiated products.[41]

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35 David C. Mowery and Bhaven N. Sampat: The Baye-Dole Act of 1980 and University-Industry Technology Transfer: A Model for other OECD Governments?, The Journal of Technology Transfer, Springer, Vol. 30, 2005, pg. 121

36 Birgitte Andersen and Federica Rossi: Beyond Bayh - Dole: Universities and the use of Proprietary and Non-Proprietary Intellectual Property (IP) marketplaces, Dynamics of Institutions and Markets in Europe, Working Paper No. 90, 2010, pg. 4

37 Wendy H. Schacht: The Bayh-Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology, Congressional Research Service, The Library of Congress, 2005, pg. 1

38 Kenneth Arrow: Economic Welfare and the Allocation of Resources for Invention, in Richard R. Nelson (ed.) The Rate and Direction of Inventive Activity, Princeton University Press, Princeton, New Jersey, 1962, pg. 617

39 Robert P. Mergers and Richard R. Nelson: On the complex economics of patent scope, Columbia Law Review, Columbia University, Vol. 90, 1990, pg. 902

40 Adam B. Jaffe, Manuel Trajtenberg and Rebecca Henderson: Geographical Localization of Knowledge Spillovers, as Evidenced by Patent Citations, Quarterly Journal of Economics, Harvard University, Vol. 58, 1993, pg. 583 & David J. Teece: Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy, Research Policy, Vol. 15, 1986, pg. 298

41 Roberto Mazzoleni and Richard R. Nelson: The Benefits and Costs of Strong Patent Protection: A Contribution to the Current Debate (1998), Research Policy, Vol. 27, 1998, pg. 275

Today the commercial value of research is increasingly understood by universities involved in research and development. This has given rise to means and methods of intellectual property commercialization to enable the technologies developed through research to reach the market. This creates a win-win situation for the university as well as the inventor.

The argument that universities must have a direct role in the national economy by producing knowledge that acts as the raw material that fuels innovation and national progress leads to the bigger picture of the role of universities in fueling knowledge-oriented economic development. By the latter part of the 1980s, thinkers were already postulating possibilities of economic development by enhancing the existing knowledge in the human resource of nations and the resultant effect on their productivity which had a big impact on higher per capita output and income.[42] One such theory is the endogenous growth theory[43] which emphasizes that although knowledge is a non-excludable and non-rivalrous factor of production, it has the capacity to generate increasing returns to scale and can thus lead to higher economic growth by significantly increasing output.[44]

This ever important role of universities in producing knowledge and contributing to the overall economy was further solidified by its inclusion in the features of the knowledge economy wherein a lot of importance was given to those industries which had a faster rate of growth than other industries and essentially traded in knowledge based products or services.[45] With the view that knowledge aids in economic growth and universities aid production of that knowledge, a third mission of directly transferring the produced knowledge to the economy has

42 Robert E. Lucas: On the Mechanics of Economic Development, Journal of Monetary Economics, North Holland, Vol. 22, 1988, pg. 27

43 The initial research was based on the work of Kenneth Arrow (1962), Hirofumi Uzawa (1965), and Miguel Sidrauski (1967) In Endogenous growth theory investment in human capital, innovation and knowledge are significant contributors to economic growth. The theory also focuses on positive externalities and spillover effects of knowledge based economy which will lead to development of economies. The endogenous growth theory also holds that policy measures can have an impact on the long-run growth rate of an economy.

44 Paul M. Romer: Endogenous Technological Change, Journal of Political Economy, University of Chicago, Vol. 98, 1990, pg. S82

45 Danny Quah: A Weightless Economy, United Nations Educational, Scientific and Cultural Organization Courier, United Nations, December 1998, pg. 19

recently gained ground along with the traditionally conceptualized missions of teaching and research for the universities.[46]

Commercialization, Intellectual Property Rights and Universities

Over the years, with time and scientific revolutions, universities have taken on another role, becoming central players in regional and national economic development through application of the knowledge created within the university. They also play an equally important role in creating economic value by way of inventions that can be transformed into commercial and feasible products in the market. The idea proposed by the economist Robert Solow that scientific and technological innovation drives economic growth got him the Nobel Prize in 1987.[47] Now, there is a general consensus that universities act as tools for economic growth via commercialization of research outputs.[48] It is today common sense that technological innovation is one of the key drivers of socio-economic development. It occurs mainly when new products or processes are created through research and development (R&D).[49]Universities contribute by way of creating the human resource of nations, who, down the line help create, adapt and absorb new and existing technologies.[50]

In this day and age of competition and changing needs of the market, the industry's needs have also changed. Be it any industry, the Software industry or the Information Technology industry or the Communications industry or even Automobiles, Aeronautics or the Pharmaceuticals industry, universities are the only suppliers of both knowledge and the knowledge workers.[51]Some of these industries do produce that knowledge which is required by them themselves but usually all industries depend on universities to create and transfer

46 Smith, H. Lawton: Universities, Innovation and Territorial Development: A Review of the Evidence, Environment and Planning, Government and Policy, Vol. 25, 2007, pg. 108

47 Nathan Rosenberg: Innovation and Economic Growth, Organization for Economic Growth and Development, 2004, p.1-6, available at www.oecd.org/dataoecd/55/49/3426/7902.pdf

48 Philip H. Phan, and Donald S. Siegel: The Effectiveness of University Technology Transfer: Lessons Learned from Qualitative and Quantitative Research in the US And UK, Foundations and Trends in Entrepreneurship, Hanover, Massachuset, Vol. 2, 2006, pg. 87

49 Sidney S. Winter: On Coase, Competence, and the Corporation, The Journal of Law, Economics & Organization, Yale University,Vol.4, 1988, pg. 169

50 R.S.M Lau: Strategic Flexibility: A New Reality for World-Class Manufacturing, S.A.M. Advanced Management Journal, Vol. 661, 1996, pg. 8

51 David Lim: Quality Assurance in Higher Education in Developing Countries, Assessment & Evaluation in Higher Education, Routledge, part of the Taylor & Francis Group, Vol. 24, 1999, pg. 383

knowledge to them.[52] Universities constantly define and redefine the boundaries of science through cutting edge research, and whenever possible transfer the technologies to the industry and society by ways of[53];

- Making available skilled human resources to the industry
- Publishing and presenting research results at national and international conferences and seminars
- Conducting contract research from the government or the industry
- Consulting work done by academicians for the industry
- Academicians training human resources in the industry
- Developing equipments that are used by the industry
- Conducting collaborative research
- Establishing industry focused or sponsored training programs
- Supporting spinoffs and licensing university technology to industry

It is no secret that knowledge from universities has found its way outside to the industry and has generated value for the economy at large. Previously it was only in the form of students, research result publications or faculties who trained people in the industry. Even now, these are the most valued outputs from the universities that are highly regarded and valued by the industry.[54] Only very recently universities and individual researchers are engaging in formal commercialization of the research results or technologies through patents, licensing those patents or at times creating start ups also called university spinoffs.

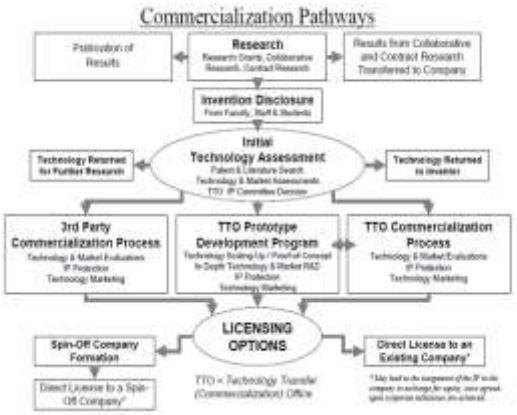
However, there is no single system of technology commercialization. Different universities have adopted different methods to achieve the same desired results. It is important to look at the process of technology commercialization used in Canada, Japan and India to understand the system and how it works. In case of Canada, the technology commercialization model of University of British Columbia is used as an example. In case of Japan, we will focus at Tohoku University and finally for India, the National Chemical Laboratory.

52 Jorge Niosi: Strategy and Performance Factors Behind Rapid Growth in Canadian Biotechnology Firms, in John de la Mothe and Jorge Niosi (Eds), The Economic and Social Dynamics of Biotechnology, Dordrecht, Boston and Kluwer Academic, London Vol. 21, 2000, pg. 102

53 Supra note 47

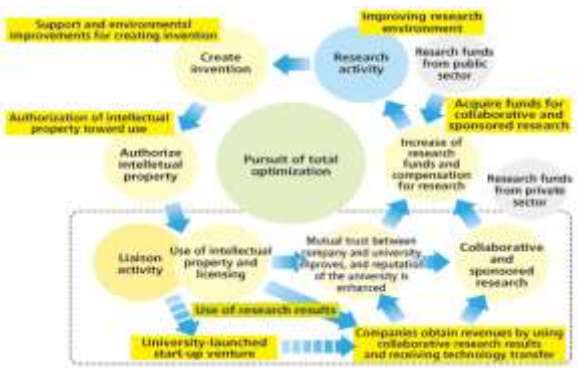
54 Wesley Cohen, Richard Nelson and John Walsh: Links and Impacts: The Influence of Public Research on Industrial R&D, Management Science, Vol. 48, 2002, pg. 15

Figure I: Technology Transfer Process at University of British Columbia, Canada:



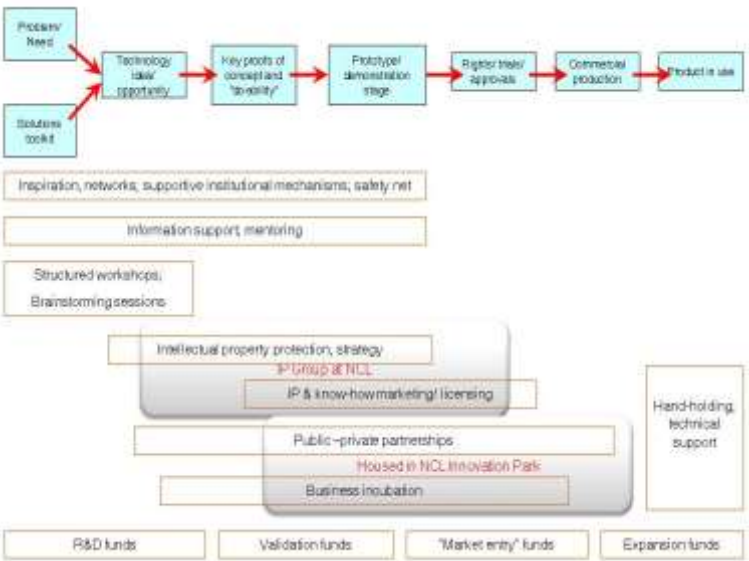
(Source: Technology Transfer Office, University of British Columbia www.ubc.ca)

Figure II: Technology Transfer Process at Tohoku University, Japan



(Source:http://www.rpip.tohoku.ac.jp/english/policy/index.html)

Figure III: Technology Transfer Process at National Chemical Laboratory, Pune, India



(Source:http://www.nclinnovations.org/aboutUs.php#Technology_commercialization)

It is interesting to note that in order to fulfill the need for intellectual creation, in all the three cases, "research activities" comes first. For this, it is necessary to "improve and enhance the research environment." The next step in the process is "creation of a technology" resulting from research. Next is the "disclosure" of the technology to the technology transfer office leading to "evaluation and protection" of the technology or the intellectual property. The last step in the process is "licensing" of the technology to existing companies or "spinoff creation". It is possible today with facilitation done by the Technology Transfer/Licensing Offices that have been set up by many universities and in many cases funded by the government that technologies developed in the universities find their way to the logical end in order to provide solutions to the society at large.

Technology Transfer/Licensing Office

The management of the transfer of technology from the university to the industry is generally performed by the Technology Transfer Office. According to OECD, a "TTO", as it is commonly referred to by technology transfer professionals, is *"this organization or*

parts of an organization which help the staff at Public Research Institutions to identify and manage the organization's intellectual assets, including protecting intellectual property and transferring or licensing rights to other parties to enhance prospects for further development." [55] According to European Commission on technology transfer from science to enterprises, a Technology Transfer Office is *"a dedicated entity which provides, continuously and systematically, services to publicly funded or co-funded Research Organizations in order to commercialize their research results and capacities"*.[56]

The rationale for the establishment of Technology Transfer Offices in universities is primarily information and coordination. The scientific and knowledge market is characterized by uncertainties since firms do not have perfect information about the commercial potential of inventions made within the universities. A Technology Transfer Office plays a filtering role thereby making the university more transparent to the outside world, whilst it invests in the creation of a reputable label or brand based on its ability to select those inventions which have the greatest commercial potential. A Technology Transfer Office is an interface that coordinates and seeks to translate the language and objectives of the scientific community for the benefit of the business world and vice-versa. It seeks to alert the scientists to the requirements of the commercialization process while, at the same time, making industrial partners aware of the potential and limitations of the technology developed within the university.[57]

It is therefore important that the Technology Transfer Office must bring together the interests of the various stakeholders namely university researcher/scientist, the technology transfer office and the external firms and provide appropriate incentives to all of them in order

55 OECD: Turning Science into Business – Patenting and Licensing at Public Research Organisations, OECD Publications, Paris, 2003, pg. 39, available at http://213.253.134.29/oecd/pdfs/browseit/9203021E.PDF

56 European Commission, DG Enterprise, Improving Institutions for the Transfer of Technology from Science to Enterprise – Expert Group Report, Conclusions and Recommendations , 2004 http://europa.eu.int/comm/enterprise/enterprise_policy/competitiveness/doc/itte_expertgroupreport.pdf

57 See generally Laura Abramovsky, Rupert Harrison and Helen Simpson: Increasing innovative Activity in the UK? Where now for Government Support for Innovation and Technology Transfer?, Institute for Fiscal Studies, United Kingdom, Briefing Note no. 53, 2004, pg. 4

to achieve its goals. [58] A snapshot of the stakeholders, their responsibilities, motives and culture is provided below:

Figure IV: Nature and Objective of the Technology Transfer Stakeholders

Stakeholders	Responsibility	Primary motives	Secondary motives	Culture
University scientists	Discovery of new knowledge	Recognition within the scientific community	– Financial gain and desire to secure additional research funding – Reputation and recognition outside the scientific community	Scientific
TTO	Works with faculty and firms to structure deals	Protect and market intellectual property	– Facilitate technology diffusion – Secure additional research funding	Bureaucratic
Firm/entrepreneur	Commercialise new technology	Financial gain associated with the acquisition of new knowledge	– Access to new technology and qualified personnel – Skill/knowledge enhancement of its scientific workforce (absorption capacity) – Maintain control of proprietary technology	Entrepreneurial

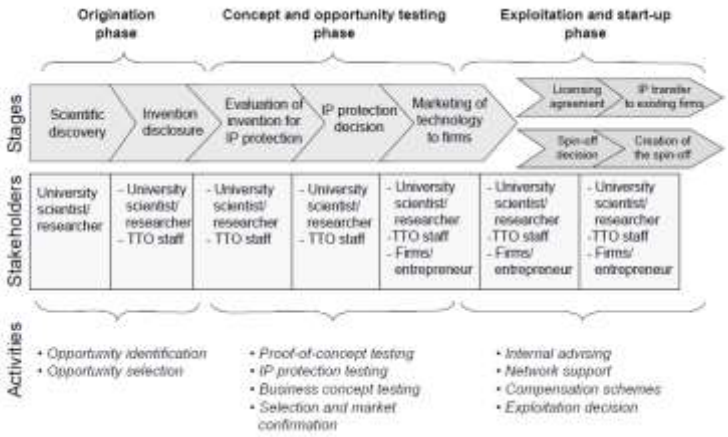
(Source: Siegel D., Waldman D. and Link A., "Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices: An Exploratory Study", 2003)

The technology transfer process leading to a licensing agreement being made with a firm or a business or the creation of a spinout is facilitated by the technology transfer office. It comprises of three major phases namely the origination phase; the concept and opportunity testing phase and finally the exploitation and start-up phase. The origination phase covers the genesis of the licensing and/or of the spin-off process. The second stage concerns the concept testing stage during which the scientific opportunity is tested and partially validated from a technical, an intellectual property and a business point of view. This phase ends up when there is a confirmation of an existing business opportunity. Finally in the last phase, the exploitation of the scientific discovery starts either

58 Donald S. Siegel, David Waldman and Albert Link: Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices: An Exploratory Study, Research Policy, Vol. 32, 2003, pg. 36

through a licensing agreement or a spin-off decision.[59] It is well expressed in the process map given below followed by a detailed discussion on each of the stages:

Figure V: Technology Transfer Office Process Map



(Source: University of Michigan, Tech Transfer Office, http://www.techtransfer.umich.edu)

The technology transfer process is interplay among various stakeholders guarding varied interests during the genesis to end use of a technology. During the 'Origination Phase', the technology is invented referred to as scientific discovery and the disclosure of the same take place. The stakeholders involved are the University Researcher and the Technology Transfer Office and the major activities undertaken at this phase are opportunity identification and selection for the technology.

The next phase, the technology passes through is called the 'concept and opportunity testing phase'. During this phase, the evaluation of the technology for intellectual property protection is conducted, decision is taken and the technology is marketed to firms or businesses; established or spinoffs. The stakeholders involved are the university researcher, the Technology Transfer Office and since it also involves marketing the technology to the industry, it also involves the

59 Jean-Jacques Degro of and Edward B. Roberts: Overcoming Weak Entrepreneurial Infrastructures for Academic Spin-off Venture, Journal of Technology Transfer, Springer, Vol. 29, 2004, pg. 339

entrepreneur as a stakeholder. The major activities undertaken at this phase are proof of concept testing to verify the underlying principle of the technology and to check if it has the potential to be used, Intellectual Property protection testing to check the strength of the Intellectual Property in the technology, business concept testing to check the viability of the business idea and finally selection and market confirmation to ensure selection of a proper market to sell the end product developed using the technology.

The third and final phase of the process is referred to as the 'Exploitation and Start-up phase'. In this final phase that the technology passes through the important stages like either licensing the technology to existing firms or creating a university spinoff occur. The stakeholders involved are the University Researcher, the Technology Transfer Office and the Entrepreneur and the activities like internal advising regarding commercial and legal aspects of the technology and business is provided by the technology transfer office. The technology transfer office also provides network support like developing business contacts, arranging finance and in some cases it also provides incubation facilities for spinoffs through business incubators, provides assistance in developing compensation schemes like revenue or equity sharing between the stakeholders and helps in the technology exploitation decision of licensing the technology to existing firms or to create spinoffs.

Origin of University Spin offs & Legislative Activity

The modern university has its roots in Germany in the 19th century and therefore it is not surprising that the earliest examples of University Spinoffs are also found in 19th Century German universities. For instance, Gusten identifies several chemistry professors in 19th Century Germany who founded companies on the basis of their technological developments and knowledge. He explains that one of the most famous of these efforts was that of Professor Johann Pickel, who produced salts, potash, and acetic acid on the basis of his scientific discoveries, and that another well-known effort was a company founded by Justus von Liebig to manufacture chemical fertilizers. [60] Many countries, in the following years, modeled their university system on the same bases established in Germany. However, early efforts to

60 Bernard Henry Gusten: The Emergence of the German Chemical Profession, 1790–1867, University of Chicago. 1975, pg. 34

commercialize university technologies were rather limited, both because of the relatively limited level of technology production at universities at this time and because of the relatively small size of universities prior to the 20th century.[61]

Morrill Act

One of the unique features of the modern day university systems was developed in the American university system. In the 19th century, the Americans enacted the Morrill Act of 1862 which granted States, land for the establishment of colleges and universities and was instrumental in the establishment of land grant universities. Section 1, Chapter CXXX, named An Act donating public lands to the States and Territories which may provide colleges for the Benefits of Agriculture and Mechanics Arts read

> *Be it enacted by the Senate and the House of Representatives of the United States of America in Congress assembled, That there be granted to the several States, for the purposes hereinafter mentioned, an amount of Public Land, to be apportioned to each State a quantity equal to thirty thousand acres for each Senator and Representative in Congress to which the States are respectively entitled by the apportionment under the census of eighteen hundred and sixty.*

The Hatch Act

The Hatch Act of 1887 followed the Morrill Act with additional federal grant funds for each state by establishing an agricultural experiment station in association with the land-grant universities. SEC. 2., 7 U.S.C. 361b, read,

> *It is further the policy of the Congress to promote the efficient production, marketing, distribution, and utilization of products of the farm as essential to the health and welfare of our peoples and to promote a sound and prosperous agriculture and rural life as indispensable to*

61 Scott Andrew Shane: Academic Entrepreneurship – University Spinoffs and Wealth Creation, Edward Elgar Publishing Limited, 2004, pg. 40

> *the maintenance of maximum employment and national prosperity and security. It is also the intent of Congress to assure agriculture a position in research equal to that of industry, which will aid in maintaining an equitable balance between agriculture and other segments of our economy. It shall be the object and duty of the State agricultural experiment stations through the expenditure of the appropriations hereinafter authorized to conduct original and other researches, investigations, and experiments bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry of the United States, including researches basic to the problems of agriculture in its broadest aspects, and such investigations as have for their purpose the development and improvement of the rural home and rural life and the maximum contribution by agriculture to the welfare of the consumer, as may be deemed advisable, having due regard to the varying conditions and needs of the respective States.*

This Act called on universities to develop and disseminate knowledge that resulted from academic research for the development of both Industry and Agriculture.[62] Furthermore, the purpose of the Hatch Act was the promotion of efficient production, distribution, marketing, and use of products and or methods that promoted a prosperous agriculture industry and resulted in national prosperity. Several entrepreneurial efforts were undertaken by academics in the late 19th and early 20th century as a way to take university knowledge and use it to help farmers and manufacturers through extension services.

While university technology commercialization efforts in the developed world were relatively small in the 19th Century, they began to grow at the beginning of the 20th century.[63] However, at the turn of the 20th century, many academics and university administrators took a negative view of efforts by faculty members to patent and license their

62 Nathan Rosenberg and Richard R. Nelson: American Universities and Technical Advances in Industry', Research Policy, Vol. 23, 1994, pg. 329

63 David Mowery and Bhaven Sampat: University Patents and Patent Policy Debates in the USA, 1925–1980, Industrial and Corporate Change, Oxford Journals, Oxford University Press, Vol. 10, 2001, pg. 790

inventions. As a result of this largely negative view of technology commercialization from the beginning of the 20th century to the early 1970s, universities' efforts to support technology commercialization and spinoff activity were more indirect than direct.[64] In general, during this period, most university researchers did not involve their institutions formally in their efforts to commercialize their inventions through the formation of new companies.[65]

University patenting and technology commercialization activity increased after World War I, a fact that can be attributed, at least in part, to the acceleration of technological development in the 1920s, as well as to the increased involvement of industry in university research.[66] However, the volume of the commercialization effort in the first part of the 20th century was still relatively low. During this period, universities produced much less technology for commercial purposes than they do today, in both absolute and relative terms. This time period also saw no appreciable change of formation of new companies to exploit intellectual property created at universities, which remained relatively low in volume and was conducted by academicians largely independently of the academic institutions that employed them. However the leading public research institutions, by this time began to institute policies and systems to manage and commercialize university generated intellectual property.[67]

As early as 1930 due to the severe financial squeeze, the great depression and the resounding success of pioneering institutions like the universities in generating income from technology licensing, there was growth in formalized university technology commercialization.[68]

The 1970s was the decade of profound change in university technology commercialization and spinoff activity. Beginning in 1970,

64 David Mowery: Trends in patenting, licensing, and the role of equity at selected U.S. universities', presentation to the National Academies Board on Science, Technology, and Economic Policy Committee on Intellectual Property Rights in the Knowledge-Based Economy, Washington DC, 2001

65 Nathan Rosenberg and Richard R. Nelson: American Universities and Technical Advances in Industry', Research Policy, Vol. 23, 1994, pg. 333

66 David Mowery and Bhaven Sampat: University Patents and Patent Policy Debates in the USA, 1925–1980, Industrial and Corporate Change, Oxford Journals, Oxford University Press, Vol. 10, 2001, pg. 792

67 David Mowery and Bhaven Sampat: Patenting and licensing university inventions: Lessons from the History of the Research Corporation', Industrial and Corporate Change, Oxford Journals, Oxford University Press, Vol. 10, 2001, pg. 323

68 Supra note 66 at pg. 799

university patenting began to accelerate, initiating the rise in university patenting activity that continues to this day.[69] This increase in university patenting activity is significantly higher than the increase in the academic share of research and development, which means that, since the 1970s, universities have seen a large increase in their patent productivity.[70]

New concept of University Spinoff

University Spinoffs have been defined in many ways by many authors. "University spinoff" is defined as a new company founded to exploit a piece of intellectual property created in an academic institution.[71] Spinoff, also known as 'start ups' and 'spinout' also means leaving "the parent organization, taking along a technology that serves as the entry ticket for the new company in a high-technology industry".[72] Locket and Wright defined university spin-outs as "new ventures that are dependent upon licensing or assignment of the institution's intellectual property for initiation."[73] The above definition does not include the companies which are not based on technology assigned/ licensed from the universities i.e. the companies which are not directly associated to intellectual assets created from research and funded by the government or the industry.

In order to commercialize, technology is moved to a separate, new venture and this development is known as spinning' off.[74] "An entrepreneurial spin-off arises when an entrepreneur leaves an organization to start a firm of his/her own. Hence, university spin-out is a

69 David Mowery: Trends in patenting, licensing, and the role of equity at selected U.S. universities', presentation to the National Academies Board on Science, Technology, and Economic Policy Committee on Intellectual Property Rights in the Knowledge-Based Economy, Washington DC, 2001

70 Supra note 69

71 Scott Andrew Shane: Academic Entrepreneurship – University Spinoffs and Wealth Creation, Edward Elgar Publishing Limited, 2004, pg. 4

72 Elias G. Carayannisa, Everett M. Rogersb, Kazuo Kuriharac and Marcel M. Allbrittond (1998) "High-Technology Spin-Offs from Government R&D Laboratories and Research Universities", Technovation, Elsevier, Vol. 18, 1998, pg. 3

73 Andy Locket and Mike Wright: Resources, Capabilities, Risk Capital and the Creation of University Spin-Out Companies, Research Policy, Vol. 34, 2005, pg. 1044

74 Stefan Görling: Methods for Assessing Technology Transfer – An Overview, Pink Machine Paper, Royal Institute of Technology, Department of Industrial Economics and Management, Sweden, Working Paper Series No. 31, 2006, pg. 4

separate venture and involves a specially formed team of people"[75] i.e. a faculty member, staff member or a student.[76]

To give one universal definition for spin-off one can take definition of spinoff which is as follow: "Spinouts involves transfer of a core technology from an academic institution into a new company and the founding member(s) may include the inventor academic(s) who may or may not be currently affiliated with the academic institution".[77]

Companies established by current or former members of a university, which do not commercialize intellectual property created in academic institutions, are not included in the definition of a spinoff employed here. Thus university spinoffs are a subset of all start-up companies created by the students and employees of academic institutions. Some others have defined spinoffs as companies founded by anyone who has studied or worked at a university.[78] Several other researchers view spinoffs as companies where academic scientists serve on scientific advisory boards in return for equity compensation.[79]

Why Spinoffs?

While university spinoffs are rare entities, they are, nonetheless, quite important. University spinoffs are valuable because of the following reasons: they enhance local economic development; they are useful for commercializing university technologies; and they help universities with their major missions of research and teaching. A detailed discussion on each of these would further clarify the justification of university spinoffs.

75 Désirée van Gorp and Pieter Klaas Jagersma: Spin-Out Business Model: A Strategic Tool for Innovative Growth, Entrepreneurship and Flexibility in the Service Sector, In Managing Business in a Volatile Environment : Balancing Local and Global Challenges. The 8th International conference on global business and economic development, Guadalajara, Mexico 7-10 January 2004

76 Raymond W. Smilor, David V. Gibson and Glann B. Dietrich: University spin-out companies: Technology Start-ups from UT Austin, Journal Business Venturing, Elsevier, Vol. 5, 1990, pg. 63-76.

77 Nicos Nicolaou and Sue Birley: Academic Networks in a Trichotomous Categorisation of University Spinouts, Journal of Business Venturing, Elsevier, Vol. 18, 2003, pg. 340

78 Edward B. Roberts: Entrepreneurs in High Technology, Oxford University Press, New York, 1991, pg. 161

79 Supra note 61 at pg. 5

Spinoffs and Economic Development

University spinoffs are important entities for encouraging local economic development. There are at least four ways in which spinoffs encourage local economic activity. First, they generate significant economic value by producing innovative products that satisfy customer wants and needs. Second, they generate jobs, particularly for highly educated people. Third, they induce investment in the development of university technology, furthering the advance of that technology and finally, they have highly localized economic impact.

It is estimated that the economic impact of academic spinoffs, measured by the amount of financial value added they generate, is relatively large.[80] University spinoffs are beneficial entities because they are very effective generators of novel products and services, creating more new innovative products and services than other technology start-ups.[81] Because firms that develop more innovative products and services satisfy important and new customer wants and needs, university spinoffs can be seen as useful entities in finding high technology solutions to unsatisfied customer demand.

Although comprehensive data on the level of investment in the development of university technology belonging to spinoff companies are not available, Golub suggests that university spinoffs are effective at encouraging investment in university technology development.[82] Another measure of the value of university spinoffs in generating investment in technology development lies in their tendency to invest in research and development. Studies have shown that university spinoffs are much more research and development (R&D)-intensive than the typical start-up company, with R&D intensity exceeding 20 percent of sales in many cases.[83]

University spinoffs are also valuable entities because they are important contributors to the economic development of the locality to

80 Warren Cohen: Taking Care of Business, ASEE Prism Online, Chicago, 2000, pg. 3

81 Desmond M. Blair and David M. W. N. Hitchens: Campus Companies – UK and Ireland, Ashgate Publication Ltd, Aldershot, United Kingdom, 1998, pg. 167

82 E Golub: Generating Spin-offs from University-Based Research: The Potential of Technology Transfer, PhD Dissertation, Columbia University, 2003

83 Philippe Mustar: Spin-Off Enterprises. How French Academics Create High-Tech Companies: Conditions for Success or Failure, Science and Public Policy, Paris, Vol. 24, 1997, pg. 40

which they belong. Firstly, they create business opportunities by translating research results into workable technologies leading to market solutions. Secondly, these spinoffs conduct most of their basic activities like their hiring, sourcing of supply, production, and so on locally and thus have significant multiplier effects on local economic activity. Spinoffs frequently serve as catalysts for the formation of geographic clusters of new firms in particular technologies.[84] The best evidence for the geographic localization of university spinoffs is that provided by Roberts. He observed that spinoffs not only tend to be founded in the same city and state as the university from which they emerged, but are often established in locations geographically very proximate to the laboratories in which they were born.[85]

In addition to the direct effect of spinoffs on local economic development, there is also an indirect effect. Because founders of spinoffs often want to retain employment at their universities while establishing their companies, the creation of university spinoffs also encourages venture capitalists and other supporting institutions to locate in geographical areas where universities are found. As a result, university spinoffs serve as magnets for the creation of an infrastructure to support the creation of new technology companies in general.

Spinoffs and Commercialization of University Technologies

University spinoffs are valuable entities because they commercialize those university technologies that would otherwise go undeveloped. Researchers have identified two ways that spinoffs enhance the development of technology. First, they provide a mechanism for firms to commercialize such inventions in which uncertainty is very high resulting in a lack of interest of other larger establishments. Second, they provide a way to ensure inventor involvement in the subsequent development of university technologies, which is crucial when technologies are based on tacit knowledge. Thursby and Thursby conducted a survey of licensees of university technologies and found that one of the most important reasons why established companies do not license university technology is the early stage of development of the

84 Robert Alan Lowe: Invention, Innovation and Entrepreneurship: The Commercialization of University Research by Inventor-Founded Firms, University of California at Berkeley, 2002, pg. 202

85 Supra note 77 at pg. 176

invention.[86] Matkin found that the most common reason for university researchers founding their spinoff companies was that existing firms would not license and develop their inventions, and they wanted their technologies to be commercialized.[87]

University spinoffs also provide effective mechanisms for involving the inventor of the technology in the process of commercialization which is a necessary condition for the development of products or services from university technology. University inventions often require additional development to be commercialized, with the knowledge necessary to undertake this additional development being tacit. Because the inventor is often the only party who has the knowledge necessary to develop the technology further, inventor involvement is a necessary condition of technology commercialization.[88] University spinoffs achieve inventor involvement because many scientists perceive that spinoffs are better places to work at because start-up companies undertake more interesting and more challenging projects than established firms, and tend to have smarter employees.[89] As a result, inventors are more inclined to work with new companies seeking to commercialize their university inventions than they are to work with established companies seeking to commercialize their inventions.

Also, start-up firms focus more of their attention on technology development as opposed to other aspects of business, and university researchers are more interested in technology development than in other aspects of business. Consequently, university inventors generally believe that they fit in better with spinoff companies and can contribute more to their development of technologies than they can to the development of technologies by established firms. And finally, equity is a more effective tool to ensure inventor involvement in spinoffs than other forms of compensation.[90] Spinoffs can provide inventors with equity holdings more easily than established firms because the distribution of equity at

86 Jerry G. Thursby and Marie C. Thursby: Industry Perspectives on Licensing University Technologies: Sources and Problems, Journal of the Association of University Technology Managers, United States of America, Vol. 12, 2000, pg. 13

87 Gary Matkin: Technology Transfer and the University, Macmillan, New York, 1990, pg. 78

88 Richard Jensen and Marie C. Thursby: Proofs and Prototypes for Sale: The Tale of University Licensing, American Economic Review, Chicago, Vol. 91, 2001, pg. 249

89 Martin Kenney: Biotechnology: The University–Industrial Complex, Yale University Press, New Haven, 1986, pg. 121

90 Richard Jensen and Marie C. Thursby: Proofs and Prototypes for Sale: The Tale of University Licensing, American Economic Review, Chicago, Vol. 91, 2001, pg. 251

the time of firm founding does not involve the transfer of equity from someone who has it to someone else, as is the case when equity is distributed after founding.

University Spinoffs and the Mission of Research and Teaching

Spinoffs are useful to universities because they help to attract and retain productive science and engineering faculty. By allowing faculty to supplement their salaries with equity in their own companies, universities provide a financial mechanism to retain and recruit faculty, particularly in the biomedical areas, that is similar to the use of practice plans common with clinical faculty in medical schools.[91] At least in the biological sciences, researchers have observed that allowing faculty to found spinoffs has been an effective mechanism to deter faculty from taking higher paying industry jobs.[92]

Spinoffs also benefit universities through the contribution that they provide to the education and training of students. Interaction with university spinoffs provides faculty with knowledge about starting companies that is useful in educating students for a world in which entrepreneurial activity is increasingly common among scientifically trained people.[93] In fact, McQueen and Wallmark propose that spinoff companies help faculty to learn about commercial uses for new technology, rather than just scholarly uses for academic inventions.[94] The incidence of university graduates working in the industry is much higher as compared to those who have an inclination towards research and might become academic researchers. This makes it very important to make them aware of the commercial uses for new technology so that they can also identify the practical value of research.[95] University spinoffs, thus, help universities achieve their primary missions of scholarly research and teaching.

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91 Gary Matkin: Technology Transfer and the University, Macmillan, New York, 1990, pg. 85

92 Walter W. Powell and Jason Owen-Smith: Universities and the Market for Intellectual Property in the Life Sciences, Journal of Policy Analysis and Management, Wiley & Sons, Vol. 17, pg. 1998, pg. 359

93 Maurice N. Richter: University Scientists as Entrepreneurs, Society, Social Science and Public Policy, Springerlink, Vol. 23, 1986, pg. 80

94 Alistair Brett, David V. Gibson and Raymond W. Smilor: University Spin-off Companies, Rowman and Littlefield Publishers, Savage, Maryland, 1991, pg. 109

95 Henry Etzkowitz: Research Groups and "Quasi-Firms": The Invention of the Entrepreneurial University', Research Policy, Vol. 32, 2003, pg. 116

Establishment of University Spinoffs

The creation of the technology used by a university spinoff is a multi-stage process. Funding from the governments, industry and foundations are used to support scholarly research in science and engineering. Some of this research, results in the creation of new technology, some of which is disclosed to the university. The university technology-licensing office then decides whether or not to seek intellectual property protection for the inventions, after which efforts are made to find licensees for them. In most cases, established companies are the licensees of university inventions, but in some cases newly formed companies are the licensees. Beginning with the initial research phase, the process of university technology development involves significant amounts of hard work, with only some efforts leading to outcomes that mark progression to the next stage.

The researcher will now discuss some of the models for creation of University Spinoffs that are widely used. The first model is proposed by Shane Scott. Next the researcher shall discuss the model devised by Vohora. And finally the researcher shall elaborate the third model as formulated by Ndonzuau.

Shane's Process of University Technology Development

Figure VI: The Process of University Technology Development

(Source: Scott, Shane, Academic Entrepreneurship – University Spinoffs and Wealth Creation, 2004)

The University Spin-Off (USO) creation process consists of several steps, stages or phases. Shane describes this process in five phases.[96] The first, second and fourth phases are considered as stages in the spin-off creation process and the third and fifth phases are decision making moments. All steps will be discussed below:

96 Supra note 61 at pg. 97

University Research: The first phase in the decision to create university spinoffs is research. Research at universities is production of new knowledge and more often than not uses funding from companies, foundations and government agencies to obtain human and physical resources required. Most of the research funding is used to pursue typical academic goals, like producing knowledge that can be published in academic journals, paper presentations at conferences, seminars etc. Sometimes, though, this research leads to technological knowledge that has the potential to facilitate new products and services. When a potential technology that has such kind of utility has been identified, the next step of creation and disclosure of the invention happens.

Creation and Disclosure of Invention: Upon identification of potential, researchers then conduct extensive research to derive results and create the technology. When a researcher believes that his or her new technology is an invention that can be commercialized, the individual is expected to disclose it to the university technology-licensing office. Before making that decision, two conditions must be met. First, the researcher must believe that the invention is something that is novel, non-obvious and valuable, rather than having produced a research result. Second, depending on the university's policy, if it so requires that the inventors must disclose their invention to the university. This is also dependent on the nature of the technology and the nature of intellectual property protection.

Decision to seek IP Protection: Provided that the research led to creation of a technology that fulfils the conditions of a patent i.e the technology is novel, non-obvious and valuable, the inventor can seek the protection of that intellectual property. If the inventor wants to seek IP protection, he or she must believe that these conditions are met. Moreover, the technology must be embodied in some form that can be patented. Tacit knowledge that only the inventor knows is difficult to protect through a patent. The next step is to market the technology.

Marketing the Technology: Only when the technology has legal protection, (by virtue of its novelty, non-obviousness and value) the inventor or the technology transfer office will try to market the technology. Licensing to established companies is by far the most used form. Approximately 86 percent of licenses go to companies that already

exist.[97] But it is not always easy to find an established company willing to invest in an often very early stage invention as the uncertainty of these investments is very high or in other words, the risk is very high. In fact, Shane suggests that a technology is likely to be exploited by a USO if the technology is:

- ***Radical:*** There is little doubt that incremental inventions would better complement an existing company, because of their advantage on market experience and market knowledge and hence radical technologies are often rejected by established firms because they could negatively affect their balance sheet and their existing products or services. These kinds of technologies undermine the existing organizational competencies and hence established firms often reject radical technology. This makes such kind of technologies, of whose capabilities; established companies are unaware of, available to the university spinoff companies and to exploit them to their true potential.
- ***Early Stage Technology:*** These technologies are usually at the 'proof of concept' stage. At this stage large established companies do not want to take the risk as the true potential of the technology is unproven and uncertain, the focus of established firms is on existing operations and finally the lack of expertise in conducting radical product development using these technologies in established firms. For this reason, many university spinoffs find it alluring to indulge in these technologies as the full potential can be unlocked by the inventors in order to compete in the market.
- ***Tacit:*** If a technology is tacit, it is difficult for anyone other than the inventor to see how an invention could be further developed into a technology that can be commercialized.
- ***General-purpose***: USOs tend to exploit technologies that are general-purpose, which offer multiple markets and are difficult for established companies to identify.

In addition to the above, Shane also suggests that a technology is likely to be exploited by a USO if the technology has:

- ***Significant customer value:*** USOs start from scratch and need to assemble the assets needed for the technology. This requires identification and use of a more valuable opportunity. The

97 Lori Pressman: AUTM Licensing Survey: FY 2001, Association of University Technology Managers, Northbrook, Illinois, 2002

technology will most likely to be exploited by a USO if it feels that the technology has the potential to provide significant customer value. It is value that is important to the customer and brings in the revenues required for the existence of the company.

- ***Significant technical advance:*** Existing companies usually conduct incremental advancements in technology as they need to be doubly sure that there is demand for their product and that the customer is informed and ready to accept the product. But as is clear now, university research might lead to novel technologies. These technologies are significantly advanced as otherwise they would not be protected under the Intellectual Property rights law. These significantly advanced technologies are the ones that university spinoffs use.
- ***Strong IP protection***: Starting USO companies have the only competitive advantage of having an intellectual property that can be further used to create end products and services. Any loophole in this competitive advantage might result in heavy loss of investments and thus spin-offs are more likely to be founded with a technology that has strong intellectual property protection so that it is safe from being tampered with by existing larger companies to their own advantage.

  After analyzing the market for the technology, the licensing decision has to be made.
- ***Licensing Decision:*** If a technology has not been licensed to an established company and the inventor believes in its success, the technology can be licensed to a newly established company. This is when a spin-off occurs. As stated above, approximately 86 percent of technologies are licensed to existing companies, which means that only 14 percent are licensed to USO companies. This number might be relatively low due to the fact that mostly academics try to license a technology to an established company instead of exploiting it through a USO as the risk bearance capacities for a USO is far limited when compared to an existing company.

Analysis

The model proposed by Shane begins with utilization of funds available for research at universities. In the process of conducting

research at times technologies are created which have the potential to facilitate the development of new products and services as research funding is primarily used to pursue academic goals. The model seems to miss out on information regarding identification and exploitation of resources prior to research i.e. the ground work before the research that can lead the research to its logical end. In the next phase of the model, the onus of creation and disclosure of research results and the resultant technology is based on belief of the researcher. It seems that this stage again is not based on analysis that is supposed to be conducted on the research results to verify it potential rather it is based on a hunch of the researcher. In the next stage, while deciding whether or not to seek IP protection, again it depends on the belief of the researcher if the research has led to a technology that is novel, non-obvious and valuable.

Shane also mentions that licensing the technology to large existing companies is the most preferred use of the research result or the technology and it is only if, for reasons discussed in the model, the technology cannot be licensed to these large firms then the inventor might start a university spinoff. Again, it seems that there is a serious lack of planning and implementation of a plan in the creation of a technology that will lead to the creation of a university spinoff. In fact, the model overlooks certain important factors that must be considered.

Beginning with a lack of opportunity identification prior to conducting research, the model also does not pay any heed to the entrepreneurial capabilities of researchers. In a way, the model also does not take into account acceptability of the technology or the products and services that the technology might facilitate by the market at large. Without possible market acceptance, production would be catastrophic.

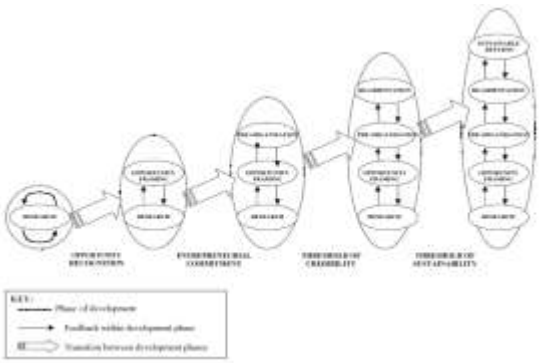
In the end, it seems that the model is more chance based rather than being choice based. Some of the very basics like understanding the phenomenon of demand and supply, market needs, market acceptance of potential solutions, competition etc. seem to have been left out.

Vohora's Model of Phases and Critical Junctures

Vohora et al. offer an evolutionary perspective on USO development. The model comprising of five phases shows that before a USO can extend itself from being a concept to reality, a specific group of

activities as well as strategic focus must be accomplished. He also discusses certain hurdles/obstacles that have to be crossed after each phase. These 'obstacles' are the critical junctures.

Figure VII: The Phases and Critical Junctures in the Development of University Spin-offs



(Source: Vohora, A., Wright, M., Lockett, A.: Critical Junctures in the Development of University High-tech Spinout Companies, 2004)

Research phase: Just as in the model proposed by Shane, as discussed above, the first phase of this process too is the research phase. This phase is essentially aimed at producing academic knowledge. This phase spans from researching a new technology, to the point that intellectual property is created. It can take a long time sometimes even years.

Vohora et al. claim that before the opportunity of commercializing is recognized, the main focus of the academic involved is to perfect the research and publish the research and the results thereof in the specific area. The transition from academic research to opportunity passes through a critical juncture of being able to recognize that opportunity.

Opportunity Recognition (Critical Juncture 1): When a USO company is at the end of the research phase, the problems that arise from moving to the opportunity framing phase are defined by the critical juncture 'opportunity recognition'. Opportunity recognition is the solution that

satisfies the need of an unfulfilled market.[98] The ability to connect the specific knowledge and a commercial opportunity requires a set of skills, aptitudes, insights and circumstances that are neither uniformly nor widely distributed.[99] It is pertinent to note here that academicians or researchers working in universities who have created the technology know the nuances of it too but they lack the ability to link that research result to the varying needs of the market. Added to that, they at times over assess the profitability potential of the technology that they create. Therefore it is clear that the ability to develop or acquire the necessary skills in order to create a market oriented and feasible offering keeping in mind the identified unfulfilled market need is the foundation upon which USOs are built. When a USO is able to link the opportunity to a specific market, it moves to the next phase, the opportunity framing phase.

Opportunity Framing phase: Here the academic and others involved will examine if the recognized opportunity has enough underlying value to proceed with the commercialization. This process involves evaluation of the opportunity and being ensured from the results arrived at that the technology is workable and has the required potential in terms of application in a commercial environment. If the opportunity can be applied in a commercial environment, the next step is to evaluate it to find out the commercial opportunity it fits into. That is, to identify the markets for the opportunity and what application of the opportunity are to be developed for those markets. Also, an assessment of customers in parlance to the innovation is critical. This not only requires entrepreneurial skills but also a strong commitment to the purpose. This becomes another critical juncture.

Entrepreneurial Commitment (Critical juncture 2): At the interface of the opportunity framing phase and the pre-organization phase lays the critical juncture entrepreneurial commitment. "Entrepreneurial commitment is necessary for a potential venture to be taken forward from a vision that the academic has created mentally, to the formation of a business that is operational and engaged in business transactions".[100]

98 Mahesh P. Bhave: A Process Model of Entrepreneurial Venture Creation. Journal of Business Venturing, Elsevier, Vol. 9, 1994, pg. 235

99 Sankaran Venkataraman: The Distinctive Domain of Entrepreneurship Research. Advances in Entrepreneurship, Firm Emergence and Growth (1997), in J. Katz, ed., Foundations Of Entrepreneurship, Scott Andrew Shane, ed., Edward Elgar Press, Vol. 3, 2002, pg. 123

100 Ajay Vohora, Mike Wright and Andy Lockett: Critical Junctures in the Development of University High-Tech Spinout Companies, Research Policy, Vol. 33, 2004, pg. 160

Entrepreneurial commitments are the acts which bind the entrepreneur to a certain course of events. In their research, Vohora et al. suggest that the commitment to the enterprise is critical because there is a serious need for the entrepreneur to have high commitment towards making the USO company a success but then finding such an individual with the requisite technological and entrepreneurial skills is difficult.[101] He also provided four reasons for this. The first reason is the difficulty in finding good role models in the area of academic entrepreneurship, from whom future such entrepreneurs can learn about the basics like the value of commitment and thinking out of the box or perceiving things differently than others. This results in reluctance on the part of academic entrepreneurs. The base of such reluctance is because they do not know how to commit, where to commit and how much to commit. Commitment leads to not only exploration of potential but also the direction of that exploration and the lack of it restricts this exploration of the potential locked in the commercialized technology. This happens because of the values that academicians imbibe and the system in which they perform. Scientist can feel uncomfortable commercializing the opportunity by themselves, and the social connections of most academics in general are restricted to the academic linkages within academia alone and not to the commercial world or the market per se. Secondly, entrepreneurs of USOs lack prior business experience for obvious reasons coupled with a genuine concern of moving from academic to market competition. At times mistrust in one's own abilities to successfully compete in the market is also a problem. This leads to a feeling of insufficiency which can display itself in poor framing of the opportunity. The poor framing of the opportunity can result in uncertain and complex decisions which can later impede smooth functioning of the USO. The third reason is an insight related to the lack of self-awareness of personal limitations and sometimes a lack of humility on the part of some academics as a result of which many USOs face difficulties in delegation or sharing of their roles, responsibilities and powers while commercializing their intellectual property. This happens so because of the years of training in academic areas where intellect is important but almost no training in areas of commercial or business skills. The fourth reason is that a USO can find it difficult to identify and acquire another entrepreneur who is apt at business and its intricacies. This is so because of limited connections, inadequate financial offers and other benefits and

101 Supra note 100 at pg. 163

the inability of the inventor to relinquish control of their company to anybody else. When the opportunity is framed within its commercial potential and the company has found, internally or externally, a committed entrepreneur, the USO moves to the next phase of development.

Pre-organization phase: Once the opportunity is framed, the development and implementation of the strategic plans can take shape. The decisions made in this phase are found to have major and unforeseeable impact upon the USO. The path that the firm will take is charted and any mistakes made in this phase can prove fatal in the future and affect the mission and strategies set. Time is of great value in technology oriented products and a small mistake can result in loss of time and revenue. The natures of the problems are such that not only experience and other human resources but knowledge of where to draw solutions from is also of great value. This phase is the one where maximum learning happens for the inventor or the entrepreneur if they lacked business knowledge regarding how the industry functions and what it values. At this stage, the credibility of the entrepreneur can take the USO a long way. Thus credibility becomes the next critical juncture.

Credibility (Critical juncture 3): Credibility is the ability of the entrepreneur to gain access to and acquire an initial stock of resources required for the business to begin to function. The lack of it critically directly impacts access to important resources like finances and human resource among others for the entrepreneur.[102] A cumulative of insufficient resources, lack of proper business links and also absence of business skills can dampen the scope of the USO. Financial investors not only desire proof of market and the proof of concepts but also a reality check on the credentials of the entrepreneur. It is not easy though as more often than not the only thing that they have to show is the intangible knowledge or the technology that they have as resources and an academic curriculum vitae consisting of publications as credentials. Also the connection with the university can be a problem at this stage. In fact, stakeholders, both internal and external value a distinct image of the company in order to have faith in the project and as long as it remains connected with the university, an identity cannot be created for the USO. The path dependency of USOs may present specific challenges like non

102 Supra note 100 at pg. 164

acceptability of the products and services offered by the USO and more commonly investors and customers may negatively view the influence of the non-commercial cultures from the university. When the USO has acquired the necessary resources, it will move to the re-orientation phase.

Re-orientation phase: After the pre-organization phase, the USO has sufficient resources and credibility to start-up the business. The USO would then focus on generating revenues. This is possible by offering value that is acceptable in the market. Now the management faces the challenge of identification and acquisition of required resources, configuring them and if needed, repeating the process several times till it produces the desired results.[103] In fact, lack of capital and managerial skills in start-up companies are factors that result in continuous re-configuration. In addition to these, information and interaction with stakeholders concerned causes a great deal of change. For example, if results in a certain category of customers are disappointing, the strategy will be realigned to target a new category of customers. The success of progressing from this phase to the next depends to a large extent on the preparatory work done during the previous phases so that actions and resource allocation and utilization of those resources are sustainable. Thus sustainability becomes critical.

Sustainable Returns (Critical juncture 4): After exploiting its technological assets commercially, the USO faces the challenge of creating sustainable return. Sustainable returns can be in the form of steady profits from revenues or promise of investment from investors. With the knowledge generated from the information gathered from concerned stakeholders, optimum utilization of available resources, honed skills and linkages developed, the management of the USO would be in a position to conduct a re-configuration, if required. At this point, weaknesses can be converted to strengths and new opportunities should be identified and explored in order to create desired results facilitating creation and delivery of value to the identified customer base. All said and done, improper identification and allocation of resources, lack of managerial skills and weak human resource that might have been carried forward from the previous phases will be tough to handle but need to be

103 David J. Teece, Gary Pisano and Amy Shuen: Dynamic Capabilities and Strategic Management, Strategic Management Journal, John Wiley & Sons, Vol. 18, 1997, pg. 515

addressed.[104] If the company has succeeded to overcome all the critical junctures, it moves to the sustainable returns phase.

Sustainable returns phase: If the USO manages to arrive in this phase, it has addressed many of the uncertainties. Typically in this phase, the company moves from the university campus to a commercial environment.

Analysis

The model proposed by Vohora provides a systematic approach for the development of university spinoffs. The model recognizes that opportunity analysis and identification is critical to research as research conducted without an understanding the opportunity will most probably result in non – commercialization of the same. It is a tricky situation as connecting academic research to a market opportunity is not an easy task and requires in addition to the scientific knowledge, sound business knowledge also. This opportunity in a way provides a broad end result of the research. But then once the opportunity is identified, the end has not been achieved. It has to be scrutinized for value in parlance to the market that it is supposed to serve. Vohora very skillfully draws the relation of opportunity to research to value to market till the second stage.

Again, he identified that the thread that ties things together is the commitment of the entrepreneur. It is commitment that is the most difficult of all the ingredients for a successful enterprise and it is that much more important for an enterprise like university spinoffs. Entrepreneurs of university spinoffs are inventors and are apt at research. Vohora identified that running a company requires capabilities in which researchers might not be comfortable owing to the lack of prior business experience. Very craftily Vohora mentions that any lack of commitment on the part of the entrepreneur might have serious impacts on the spinoff as it will impact the vision, mission and strategy of the spinoff.

The model also takes care of the most important element in business called decision making. A right decision can mean success and a wrong one may mean closure. Decision making is extremely important in case of university spinoffs as entrepreneurs here not only lack

104 Supra note 100 at pg. 167

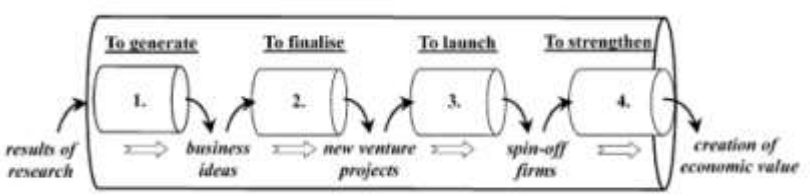
experience of conducting business but also do not have access to networks of expertise and understanding the consumer. The model rightly identified that the credibility or the goodwill of the entrepreneur is also pivotal in securing finances for the functioning of the company among other things.

There is no doubt that the market is in continuous transformation. This is so because of the changing competitive environment, changing tastes and preferences of the consumers, flow of information, changing legalities etc. The model takes this too into consideration. And finally keeping the modern business practices in mind the model bring the process to a logical end of sustainability. This is a rather wholesome process.

Ndonzuau's Academic Spin-Off Creation Process

Ndonzuau et al. identify four stages in the development process of USOs. The four stages identified are from a public and academic authority's point of view. This is done by benchmarking international spin-off support programmes. The four stages of the model are not wholly independent from each-other; decisions made in an earlier stage can have an impact on the later stages. Ndonzuau et al. identify "obstacles, impediments, hindrances and other sources of resistance" that need to be overcome in each phase. These are called 'issues' in their research.

Figure VIII: The Academic Spin-off Creation Process



(Source: Ndonzuau, F. N., Pirnay, F., Surlemont, B. A stage model of academic spin-off creation, 2002)

Generating Business Ideas (Stage 1): The first stage in this process deals with the generation of a viable business idea. This can be difficult

because of the academic culture and the problem of identifying business ideas.

- ***Academic culture:*** The academic culture plays a very important role in this regard. The usual culture of 'publish or perish' in a way influences researchers to keep working on new areas and publishing results whereas the researcher pays little heed to the application of the research in finding new solutions for the public at large. It is no secret that the relationship of researchers to money has at best remained platonic. In the academic culture, researchers consider money as a means of scientific progress. In the business sphere however, other liabilities such as financial results and project delays have to be taken into account. The disinterested nature of academic research is also an important factor of why the academic culture can be problematic in creating business ideas.
- ***Identification of business ideas:*** Another very important factor in the first stage is the identification and assessment of ideas. A technology with has to be identified and a business idea has to be conceived accordingly requires sensitive contacts, development of mutual trust, and organization of an efficient system of internal diffusion of information.[105] After an idea has been identified, it should be assessed on its technological, commercial and personal aspects. Technological evaluation requires the ability to assess the extent to which research results are stable and/or sufficiently developed to lead to industrial exploitation by identifying their possible applications, assessing their technical feasibility, and, in some circumstances, suggesting further research and development. This can be done by internal partners (i.e. professors) or external partners (i.e. consulting firms). After the technological evaluation, the market potential must be assessed and compared with the entrepreneurial ability of the inventor. Only after proper evaluation of the technological, market potential & entrepreneurial ability, a transition to the next stage is possible.
- ***Finalizing New Venture Projects (Stage 2):*** After stage 1, ideas are generally ill-structured with many grey areas to be clarified, while their potential to make money is not yet precisely known.

105 Frédéric Nlemvo Ndonzuau, Fabrice Pirnay and Bernard Surlemont: A Stage Model of Academic Spin-Off Creation. Technovation, Elsevier, Vol. 22, 2002, pg. 284

In the second stage, the idea must be transformed into a business project. This process requires major investments and consists of the protection and development of the idea.

- ***Protection of ideas:*** First, it must be clear who the owner of the idea is. This is often far from clear because of multiplicity of funding sources, the diversity of conventions established between funding organizations and teams of researchers, the collaboration between different research centers (public or private), the various status of people carrying out research activities (professors, contractual researchers, doctoral students, and so forth), and, finally, the intangible character of most results. All these elements contribute to complicating the task of protecting intellectual rights and require an in-depth analysis to determine who the owner of the idea is.

  The next step is to efficiently protect an idea. High technological level and barriers of imitation can protect an idea naturally for a considerable period of time. Most academic results do not have high barriers, so they must be protected through artificial protection such as patents and copyrights. This requires specialists who understand how to formulate a patent. The protection of intellectual right can be costly and hence a cost-benefit analysis must be conducted on the usefulness of such legal protection.
- ***The development of business ideas:*** At this stage, the decision must be made on how to best exploit the idea. If the decision is made to exploit the idea through a spin-off, a transformation of the idea into a business project is required. This involves technical and commercial development along with arrangement of financing.

  The purpose of technological development is to verify the possibilities of industrial exploitation. [106] This is done by conducting a prototype which can determine whether production can be extended to a larger industrial scale and also to demonstrate to potential customers and partners what the technology can achieve. This requires material issues like the availability of technical facilities that may be necessary to build up a prototype and non-material issues like the time of development.

106 Supra note 105 at pg. 285

After technological development, the commercial development occurs in order to determine whether the idea is a business opportunity and if so, then in which way this opportunity can be exploited. This requires a solid business plan as it helps to design a coherent strategy and to estimate more accurately key elements such as investments, turnover, operating costs, or treasury forecasts and also gives a concrete form to a selling document for bankers and investors by giving them a structured and coherent image of the ways in which the results are intended to be exploited.[107]

Problematic in the technological and commercial development process is to finance this stage. Legal protection is often supported through the university, but for technological and commercial development, it is difficult to find funding. Public funding is dedicated to fundamental research, and very few private financial bankers invest in such early stage idea, in an unpredictable and instable high-tech market, conducted by researchers with often low entrepreneurial capabilities. This is called the 'financing gap' and is undoubtedly the key problem to overcome in order to finalize these projects.[108] Once, these issues are taken care of, the process moves on to the next phase.

Launching Spin-off Firms (Stage 3): This stage deals with the creation of a new firm to exploit an opportunity managed by a professional team and supported by available resources.[109] At this stage, the process of commercialization takes place, moving from specific academic contingencies towards business considerations. This brings two important problems: the availability of resources and the relationship that should be established between the spin-off company and the university. Dependent on their policy toward spin-offs, some universities can help overcome these problems to find solutions for these issues such as raising venture capital funding.

- ***Access to resources:*** Both tangible and intangible resources are needed to realize entrepreneurial projects. The management and creation of a spin-off is very different compared to the research activities that academics normally perform at the universities.

107 Supra note 105 at pg. 286

108 Bjornar Reitan: Fostering Technical Entrepreneurship In Research Communities: Granting Scholarship to Would-Be Entrepreneurs. Technovation, Elsevier, Vol. 17, 1993, pg. 288

109 Supra note 108 at pg. 292

They will have competitive pressure and they will have to be surrounded by competent people to avoid mistakes. The main reason of failure is often not the poor business idea but the poor quality of the management. The development of a business requires management expertise and good social networks. The problems that arise from this are how to identify key people and how to involve them in the spin-off company.

- ***Relationship with university of origin:*** Eventually, all USOs will leave their academic environment, but most of the USOs retain some relationship with their original university. This can be through an institutional level such as equity shares (financial resources), patent technology ownership by university (intangible resources) and access to university facilities (material resources). But it can also be through a personal relationship between the university and the researchers. This could be through incidentally benefiting from effective research infrastructure accessed at a lower cost than available in the market, or universities that unintentionally subsidize some activities of the spin-offs with a view to create economic value from the venture.

Strengthen the Creation of Economic Value (Stage 4): All endeavors academic or commercial must in one way or the other create economic value to be important to its local, national or global environment. As a matter of fact, this phase is the most important stage for the USO. This is where the technology reaches its logical end of contributing value to the customers, employees, investors, and all other stakeholders (both internal and external). This stage on the creation of economic value from a USO is from a public perspective and does not consider the development process of a USO itself.

Analysis

The model proposed by Ndonzuau is more oriented towards business. It starts with the generation of a business idea but is careful in keeping the academic culture and other problems of identifying a business idea in mind. In fact the model goes a step further and discusses the importance of cementing the idea and turning it into a viable business project by looking at the protection that the idea or the technology has. This model also suggests a prototype test of the technology and then balancing the business idea accordingly to satisfy the consumers and

other stakeholders like the financers. The model realizes that finance is the backbone of any enterprise and duly appreciates it.

Then the model goes on to include the launching of the spinoff but even at this stage pays importance to the availability of resources and additional funding. Finally, the model focuses on the creation of economic value from the activities of the spinoff taking the process to its logical end.

A compact and methodical model, Ndonzuau values the realities of business in this model and displays a very resourceful insight into the formation, development and sustenance of university spinoffs.

Conclusion

Most of our knowledge has been produced in Universities across the world not only in the early or the medieval period only but also today. Universities are one of the major contributors to technological invention and innovation. As a result of their research activities, new areas are explored, the frontiers of knowledge are pushed forward and sometimes even the foundations of new industries are laid. They also train the human resource and create human capital.

Research has always been an important function of the university system. Universities which conduct only research and at a very high level are known as Research universities. They form the pinnacle of the academic system, typically serving only the most able students and constituting only a modest number of institutions. These universities are not only committed to bringing research to the centre of the academic enterprise but also aim to link research to real time applications and thereby foster and national development. To facilitate cutting edge research and first class training to the society, universities world over have developed indigenous Science and Technology system. This system is an intricate mix of complementary university resources comprising of financial, governance, human, intellectual, and physical capital resources that together create productive processes including research, education, training, and socialization that generate a wide range of socially valuable research outputs intellectual and human capital.

Since the Second World War, a new practice developed as regards to universities. In the developed countries universities were expected to play a more express role in nurturing economic growth and national competitiveness. This resulted in the developments of an economic thinking that justified the interpretation of universities as crucial in sustaining national competitiveness. It was clear that a push for an increase in the number of higher education students would be essential for the knowledge economy. But it was not enough and this changed the relationship between universities and Intellectual Property. The emphasis on the economic role of the university producing knowledge as the raw material that fuels innovation and national progress builds upon the broader economic debate of knowledge-driven economic growth.

Today the commercial value of research is increasingly understood by universities involved in research and development. This has given rise to means and methods of intellectual property commercialization to enable the technologies developed through research in order for them to reach the market. This creates a win-win situation for the university as well as the inventor. It is possible today with facilitation done by the Technology Transfer/Licensing Offices that have been set up by many universities and in many cases funded by the government that technologies developed in the universities should, as far as possible, find their way to the industry in order to provide solutions to the society at large.

Our research on three different models of translation of university research results into commercializable end products through university spinoffs have shown that essentially a lot of planning has to be done in order to identify the area of research to begin with, a concerted effort to understand the need of the industry where that research can be applied and finally be able to create an environment wherein entrepreneurial ventures can take shape. In the event of any diversion from the process, it is difficult to derive the end result of being able to commercialize university research results leading to greater economic prosperity.