Foreword

Henry Etzkowitz

TOWARDS AN INNOVATIVE SOCIETY

Innovation is being transformed from a relatively simple set of linear and reverse linear processes within industry, extending from research to the market and vice versa, to a non-linear process in the transition to a knowledge-based society. Beyond the development of new products, innovation is the creation of new configurations among the institutional spheres. University–industry–government interactions are increasingly the basis of economic and social development strategy in both advanced industrial and developing societies. The transition to a 'triple helix,' characterized by interdependence among relatively autonomous institutional spheres, takes place from divergent starting points of 'statist' and 'laissez-faire' regimes.

In some countries, there is a movement away from an assumption that there is a single starting point of research and an end point of the economy: an autonomous linear model based on laissez-faire assumptions in which innovation takes its own course. In other countries in transition from a central planning to a market economy, a role for government was temporarily lost. In still other countries, government is struggling to find a balance between playing a significant role and stifling initiative. It is increasingly recognized that government plays an important, if sometimes hidden, role in innovation in market economies and that government programs have an important role to play, not only from the national level – top-down – but also from the local level – bottom-up – in a movement from a 'hands-off linear' to an 'assisted linear' model of innovation.

Direct links among university, industry and government helped produce weapons from science during the Second World War. These links were dismantled immediately after the war, but were revived in an indirect format from the 1970s. Ideological opposition to government–industry relationships was diverted by mediating ties through the university. An assisted linear model has replaced the passive linear model in the US. A meta-innovation system comprising bottom-up, top-down and lateral

initiatives, from university, industry and government, individually and collectively, translates research into use. A triple helix of university–industry–government relations, as the basis of innovation policy, can be identified in countries that are emerging from statist and laissez-faire regimes.

BEYOND THE LINEAR MODEL

The linear model, moving from research to utilization, has been much criticized in recent years. And there has been more of a focus on the reverse linear model – looking at the problems in a firm or in society and then working to solve those problems. This is more related to incremental innovation, which, of course, is important and is a necessary part of the picture, especially into the university and into longer-term research problems. But even though the linear model is much criticized, no one can actually give it up. We seem to still find that we can't do without. What we realize now is that it must be modified. The original idea was that simply by putting in the research funds – typically by government at one end – then the results would be published, would go to industry and then industry would take them up. Now we know it's not so simple a process. Of course, that sometimes happens. That is what I think, broadly, we are moving towards.

Here are the traditional ways of starting from either end – starting from research and questions in our discipline. Or starting from problems in society and then finding the solutions to those problems. Some places are more closely tied to one model or the other. New York is very much tied to the reverse linear model. Historically, Thomas Edison moved to New York from Boston, then the high-tech center of the US in the late nineteenth century – he moved there to be closer to the financial center. He went to work for J.P. Morgan, to solve problems in the finance industry – communications problems through advances in telegraphy. From there he went on to solve problems in society and introduce new inventions for entertainment, such as the phonograph. Many software firms are still created and developed in New York to work with the financial industry or the media and entertainment industry that grew out of Edison's early inventions. In the New York innovation environment, there is still a weakness on the linear side. That gap has finally been recognized by the city and addressed by the Cornell Technion collaboration, for a graduate engineering school.

THE OPTIMUM ROLE OF GOVERNMENT

What is the optimum role of government in innovation? A Swedish university liaison director recently asked, why a triple helix? Why not a 'double helix' of university–industry? The answer is that it is only possible to develop university–industry relations up to a point, without considering the role of government. In the late 1970s, the US Secretary of Health, Education and Welfare rescinded the authority that had been developed by precedent in the National Institutes of Health to transfer intellectual property rights to universities on a case-by-case and university-by-university basis. Stable conditions for disposition of intellectual property arising from federally funded research were re-established by law in 1980 and technology transfer assumed the format of a business-like activity between university and industry (Berneman and Denis, 1998). Government's role in establishing a legitimate framework for technology transfer was the basis of this relationship.

The role of the state in innovation is most clearly apparent in countries such as Mexico, where state-sponsored industry sector associations and university consultative councils coordinate these spheres. The Singapore government organized the transition to high-tech manufacturing and then to knowledge-based economic development. The US has established a series of programs and a regulatory environment to facilitate technology transfer in order to reap the benefits of the munificent research funding that followed the Second World War. Other countries, such as Sweden, with high rates of R&D spending and relatively low rates of economic return, are currently undertaking parallel steps.

BEYOND THE ENDLESS FRONTIER

Despite numerous 'eloges' for the linear model, especially in its forward format, a trend toward increasing reliance on science-based innovation can be identified in different countries. In Sweden, it is represented by a new research funding sector focused on 'strategic' science, in Singapore by the founding of a science-based institute sector and in the US by interagency research initiatives such as those in nanotechnology, supported by the Department of Energy and the National Science Foundation (Edquist, 2003). It is expected that many of the results of these initiatives will be introduced into the economy, not by firms tied to existing industries, but by new firms seeded by government funding as the basis of future industrial sectors.

The innovation state attempts to regenerate the sources of productivity,

through such investments in science and technology, and by changing the rules of the game, through legal and administrative adjustments, to encourage the creation and growth of new firms. The state increasingly undertakes these tasks, not as a sole actor but through new forms of cooperative relations with industry and university. The innovation state is the successor to the capitalist, Keynesian and welfare states, with their respective foci of assisting existing industry, promoting general economic advance and securing the basic conditions of a good life for all the population (Jessop, 2002).

The innovation state builds upon these various bases, incorporating elements of each these models into a broader framework to support their realization under changed conditions of global competition. Neither socialism nor capitalism as an isolated national model is feasible but it is difficult to give up policies to realize these goals. In the laissez-faire model of separate institutional spheres, moving beyond Keynesian macroeconomic policies arising from the depression of the 1930s, such as central bank adjustments of interest rates or money supply, was also a difficult transition. Similarly, in statist societies, the relaxation of the total state, based upon central planning, to a more modest role of incentivizing innovation, without going all the way to inaction, was also a difficult transition.

Thus, one path to the innovation state is from a top-down model of bureaucratic control, with the state devolving its authority to various degrees. The other is from a standpoint of modest participation by central government, in which case the pathway is to increased activity. The two different starting points intersect at some mid-point, where government, industry and university assume relatively equal status as interdependent institutional spheres.

THE TRIPLE HELIX

The triple helix is an analytical and normative concept derived from the changing role of government in different societies in relation to academia and industry. Interaction among university–industry–government, as relatively independent yet interdependent institutional spheres, is the key to improving the conditions for innovation in a knowledge-based society. A triple helix coordinated entirely by the state only provides a limited source of ideas and initiatives. Under these circumstances, government may take initiatives without consulting others; indeed it may subsume the other institutional spheres and direct their activities. Although large projects may be accomplished, it is not the most productive form of triple helix relationship, since ideas are coming from only one source – the central government.

Conversely, if the state is absent from the innovation picture then the coordination, regulation and funding necessary to encourage improvements may be insufficient. There is no single answer to finding an appropriate balance between intervention and non-intervention. However, the previous history of the role of the state in society will set some bounds and also determine whether it is most useful for the state to intervene directly or indirectly, acting through other institutional spheres. In statist societies, direct intervention is expected, while under laissez-faire conditions, only indirect approaches may be possible.

Cross-national comparisons are instructive to explain why the same organizational mechanism can produce different outcomes in different contexts. For example, a Mexican researcher has asked why the incubator has been successful in Brazil but not in Mexico. One explanation is that an incubator movement arose in Brazil with industry associations, local and national government supporting university initiatives, rather than being an isolated top-down initiative. The Mexican government has a program to provide funds to universities to start incubators. However, it is a relatively limited project with a very narrow base of support, rather than a movement that has spread throughout the entire society. In Brazil, the incubator initiative was part of the revival of civil society in the post-military era, with various institutional spheres involved, and national government being only one among several sources of support.

The existence of an organization infrastructure to receive a new element also explains why transfer may 'take' or be rejected. An initial attempt to introduce CONNECT, a local level networking format from San Diego to Sweden, made by members of the local biotechnology association in the Skane region did not succeed, lacking sufficient support from the region and the university. A later effort undertaken by the prestigious Academy of Engineering in Stockholm attracted support from regional officials and universities across Sweden and several CONNECT networks, linking entrepreneurs, business advice providers, patent lawyers, accountants and angels, were successfully established (Walshock, 1995). The cultural carryover of a top-down tradition of initiative was decisive.

Different state capacities affect both the trajectory and visibility of a triple helix, whether it is organized openly and transparently or is routed through hidden channels. In 'high state' societies, where triple helix relationships have traditionally been directed from the top down, bottom-up initiatives appear in conjunction with the emergence of regions and the growth of civil society. In 'low state' societies with a laissez-faire tradition, the emergence of the triple helix is associated with a strengthening of the role of the state, acting together with university and industry. Activating regional levels of government to become innovation actors, and creating

such levels when they are lacking, becomes a key issue in creating such a system.

DEVOLUTION OF THE CENTER

There has been a significant devolution of powers in recent years in countries, such as Great Britain, France and Sweden, lacking a strong regional level of governance (see Greyson, 2002). Formerly central government operated through regional levels that mandated common polices. Increasingly it is seen that it is necessary to have policies specific to the competencies and capacities of different areas. Given the lack of an activist regional tradition, an initial step from the center may be to incentivize regional actors to come together and develop new initiatives. Sweden's Innovation Agency, VINNOVA, has taken this approach in a funding competition based on triple helix actors developing joint proposals for science-based innovation.

On the other hand, there is a need to knit together different local initiatives that might otherwise be at odds with each other. Many innovation initiatives have been established by Swedish government agencies and foundations. Government has provided the universities with 'holding companies' to transfer technology and help start new firms but it is only a modestly funded initiative. Technology Bridge Foundations were established in several regions with a significantly higher level of funding, for much the same purpose. The triple helix model provides a rationale to cooperate and aggregate resources to a common end and reduce friction among what otherwise might be a set of small competitive projects.

THE CHANGING ROLE OF GOVERNMENT

Top-down models have been highly successful in organizing large military and space projects in both socialist and capitalist regimes. In countries with a planning system, government kept the entire innovation process under its control. Thus, in the former Soviet Union and Eastern Europe, a system of research institutes focused on industry problems. However, the results could only be implemented if they were centrally approved, although there were always informal exceptions to the rule. Nevertheless, bureaucratic controls were an impediment to introduction of inventions. Although research and production were formally linked by intermediary organizations, industry's focus was on quantity production, not qualitative innovation and local technology transfer.

TRANSITION FROM STATISM TO LAISSEZ-FAIRE

In the post-socialist era, top-down coordination was removed and each element in the former system was left to fend for itself, with sharply reduced funds from the state. The abrupt reconfiguration from a statist to laissez-faire regime left a question mark where the state had formerly played a leading role. Science and technology policy had formerly been the centerpiece of regimes legitimated by a thesis of a 'scientific–technological revolution.' Given the discrediting of government, it was difficult to justify more than a minimalist state, confined to basic security and welfare activities. Science and technology policy was barely a legitimate activity, no longer a priority in post-socialist countries. Nevertheless, after more than a decade of 'hands off,' it is said that 'government officials have come to their senses and realize that Government should stimulate . . . reforms' in Russian science and the academic community (Mirskaya and Yakov, 2004).

TRANSITION FROM STATISM TO CIVIL SOCIETY

The possibility of individuals and groups to freely organize, debate and take initiatives, is the basis for a triple helix including bottom-up as well as top-down initiatives. This can be seen most clearly in countries that are just emerging from military dictatorships. Bottom-up initiatives became possible in Brazil with the re-creation of civil society that took place when the military gave up control in the early 1980s. University science and technology researchers introduced the concept of the incubator from the US. In succeeding years, various levels of government as well as industry and civil associations took up the incubator concept and spread it throughout Brazilian society, applying it to a variety of problems from raising the level of low tech industry to creating jobs for the poor (Etzkowitz et al., 2005).

TRANSITION TO AN INNOVATION STATE

The Finnish case is a focused version of the linear model of R&D pump priming, with funding opportunities focused on a relatively few areas of IT and biotechnology identified as having future economic potential. Much less research-intensive in the early 1990s than Sweden, Finland has moved ahead by using monies from privatization of public enterprises to sharply raise the level of R&D spending (Benner, 2003). To ensure that the Nokia success was not an isolated instance, Finland made innovation a direct responsibility of the Prime Minister's Office. In a relatively few years, the

Helsinki region has come close to Stockholm in its concentration of biomedical research. The city of Tampere is now home to 3,000 information technology researchers in contrast to few dozen in the early 1990s.

TRANSITION TO AN INTERVENTIONIST STATE

The US is traditionally perceived as a laissez-faire society. Thus, there is reluctance to recognize that a plethora of specific policies and programs accumulated over the past half-century constitutes a US innovation policy. Government is playing a greater role in promoting innovation, often utilizing the university to reach its objectives. Given the resistance to government action at the federal level, when intervention is decided upon it typically occurs indirectly, utilizing universities as an interface between government and industry. In response to ideological constraints, the trajectory of immanent industrial policy formation creates networks and initiatives that cut across the institutional spheres.

Behind the laissez-faire presumption of the linear model that academic research results would seamlessly pass to industry through graduated students taking employment and industrial researchers following the journal literature, a more focused organizational approach to technology transfer, utilizing the patent system, had grown from its origins at MIT in the early twentieth century. According to a university official, 'the national innovation strategy is to put federally-funded R&D on a conveyer belt that gets the R&D commercialized either by tech transfer to established companies or by wrapping the R&D into a university start-up' (Stanco, 2004).

US INNOVATION POLICY

Despite ideological structures against industrial policy and disbelief in the efficacy of attempting to 'pick winners,' the US has arguably the world's strongest innovation policy, comprising bottom-up pressures from aspiring research universities, less research-intensive states, federal agencies under pressure to show practical results from research funding and increasing international competition. No single impetus is decisive; rather it is the interaction of the various forces and initiatives that has generated an active innovation model wherein, if one level is forced to be inactive, say the federal government in supporting stem cell research, the state level picks up the slack, as in California's project to support research on this topic with a $3 billion bond issue.

During the post-war period in the US, high overhead payments became

a method of funding the major research universities directly from the federal government without explicitly acknowledging an elitist federal higher education policy. These universities thus supported were clustered in relatively few parts of the country, on the East and West Coasts, with a few in the Midwest. This disparity was not a major issue as long as academic institutions were primarily seen in their traditional role as educational and research institutions. As a few universities with concentrations of research became foci of economic development, other less research intensive regions wished to emulate their success.

Pressure has increased on the federal government to increase research spending and to distribute it more broadly, eschewing peer review mechanisms instituted in the early post-war years to focus federally funded research at a relatively small group of schools.

Nevertheless, regions with low levels of federal R&D spending are unwilling to depend upon modest set-asides, instituted to reduce pressures for equalization, or slowly building up their capabilities with local funds. Therefore a science policy is instituted that works the same way as appropriations for roads or bridges or any local improvement that a senator or congressperson wants. A legislator attaches a provision for a research center for a local university to a bill for another purpose, the so-called 'earmark.'

Universities that have been outside of the research system but want to increase their research strength have also been active in seeking these funds. Typically as this new group of research universities enhances its capabilities through such targeted measures, the universities then begin to compete successfully for peer-reviewed funds through the normal research funding channels. It is this increase in competition from universities across the country that has given the older research universities the feeling – indeed it is a reality – that competition for research funds has increased even as federal research budgets have risen significantly, especially in health and security.

BOTTOM-UP ACTIVATES TOP-DOWN

As new industrial areas arose from an academic research base in molecular biology and computer science in a few locations, other parts of the country became aware of the significance of universities as engines of economic development and wished to follow this model; first in North Carolina in the 1950s. By the end of the 1980s, virtually every state had some kind of science and technology agency focused on creating economic growth from research, typically by expanding research at local universities. In addition

to state governments' funding, research focused on economic development rose to a total of three billion by the turn of the new century, although it has since declined somewhat due to budgetary pressures (Berglund and Coburn, 1995).[1]

Strategies typically follow from the industrial and scientific condition of the state. Less research-intensive states attempt to build up the research capabilities of local universities in fields related to local resources. A longer-term goal is to create new firms from this research. Oklahoma and Georgia offer research funds to professors who have developed successful research groups to entice them to relocate, thereby improving the competitive chances of the state's universities in the federal research funding system. On the other hand, research-intensive industrial states, such as Michigan and New York, fund their universities to develop research capacities related to existing industries.

THE EMERGENCE OF A 'BOTTOM-UP PLANNING SYSTEM'

Although states can be explicit, the federal government can only set very general outlines in civilian innovation policy for fear that it will be accused of attempting to 'pick winners.' Government is ideologically perceived as naturally and inevitably incompetent, despite manifest success in military, health and agricultural innovation. Nevertheless, it is advisable to watch what the US does rather than what it says with respect to the government's role in innovation. Even the most conservative politicians are activists when it comes to creating new knowledge-based industry in their locality.

There are additional positive implications of innovation policymakers having to deal with ideological resistance to government interventions. Since it is only considered to be legitimate for government to intervene in the event of clear 'market failure,' such as the need to support basic research, policy measures are forced upstream toward the research frontier.

This tends to lead to a focus on start-ups and on creating new industries rather than providing input into existing industries. Policy measures are typically instituted as an extension of basic research funding programs that take the form of grants rather than loans. Thus a higher degree of business risk can be taken. Again this is conducive to supporting the early stages of bringing advanced technology to the market. On the other hand, it is more difficult for the federal government to take steps to support later stages of firm growth and development, with the important exception of military- and security-related technologies.

INDIRECT INDUSTRIAL POLICY

Increased international competition called attention to the role of government in innovation. During the economic downturn of the 1970s, there were proposals for government to become directly involved in aiding existing industries and building up new ones, but these were quickly defeated. Instead, government went through the universities to reach industry. The patent system was reorganized to give intellectual property rights from federally funded research to the universities, with the condition that they had to take steps to put them to use. After 1980, technology transfer mechanisms that had only been utilized by a relatively few universities were diffused throughout the research university system (Etzkowitz, 2002).

Since the late 1970s, the federal government has played an indirect role in encouraging academic–industry cooperation by changing the legal framework for federally funded research at universities. Laws such as the 1980 Bayh-Dole Act were passed to tie government-supported basic research at universities more closely to industry by creating a series of incentives and requirements to encourage universities to transfer technology deriving from federally funded research on campus. The new framework requires and offers incentives to encourage academic institutions to commercialize their research.

This policy has led to the emergence of a technology transfer profession, primarily based at universities. Their task is to negotiate agreements to move research across boundaries from one sector to the other. Intellectual property is licensed by the university to a company, often with little continuing academic involvement apart from consultation. Occasionally, a more intensive effort takes place locally through the founding of a firm, with continuing academic participation in research and product development. The 1980 Stevenson-Wydler Act extended the effort to transfer technology from research organizations to industry by mandating technology transfer efforts by the laboratories and research agencies of the federal government. The objective is to take intellectual property or capacities that exist within government laboratories and infuse them into companies as a part of a strategy to improve their international commercial competitiveness.

GOVERNMENT → INDUSTRY INITIATIVES

In addition to regulatory changes, basic research funding models were adapted to close the gap between research and innovation, the so-called 'valley of death.' To solve this problem, programs have been created that provide support for the early stages of firm formation. This 'public venture

capital' does not take minority ownership but fulfills the seed capital function in all but name (Etzkowitz et al., 2001). For example, the NSF program officers who founded the Small Business Innovation Research (SBIR) program created a neutral language for direct government intervention in the economy. They delineated a three-phase model of the entrepreneurship process, with a transition from public to private funding in the third phase.

The strong focus on scientific and technical criteria provided a resemblance to (previously justified) basic research. Finally, 'small business' can be viewed as a strong ideology by itself that very few people oppose. An advocate of SBIR and similar initiatives said 'we definitely see the programs as a de facto industrial policy, but we cannot use that term, so we usually call it R&D policy and things like that instead; but it [SBIR] is a federal program that has created a whole lot of new industrial activity' (Etzkowitz, 2008, p. 69). Nevertheless, SBIR officially operates as a grant based federal R&D procurement program for small business.

Several other federal programs, such as the Manufacturing Extension Centers of the National Institute of Standards and Technology, provide support that have allowed state initiated programs to expand their efforts. The focus of these new collaborative arrangements is on translating research capacities into economic development. Recent US policy shifts have led to the growth of technology transfer capabilities in government laboratories, modeled upon university initiatives. A cooperative R&D agreement mechanism (CRADA) has been created to encourage and subsidize collaborative technology development projects between federal laboratories and industry. Consortia of companies, large and small, and universities are being supported to develop new technologies in response to international competition.

INDUSTRY → GOVERNMENT INITIATIVES

Government–industry R&D cooperation is emerging as an overlay upon a 'hidden industrial policy' of encouraging academic–industry ties. Incentivized by relaxation of antitrust laws US industry initiatives are largely confined to joint projects among firms. However, in certain circumstances, where the challenge is great and industry feels it cannot succeed by itself, and the danger of loss is too great, industry calls upon government assistance. Two instances exemplify industry's relation to government: the formation of SEMATECH and Joint Venture Silicon Valley, at the national and regional levels. During the decline of Silicon Valley in the early 1990s, an industry initiated consortia invited participation of local governments and universities in what was initially a series of brainstorming meetings

to generate ideas for renewal of the region. A 'venture capital' approach of selecting a few ideas for further development was followed and an organization was formed to support the initiatives, led by a local politician.

When the semiconductor industry was at risk due to intense Japanese competition from the 1970s, industry leaders developed a strategy to jointly develop a new generation of production technology and sought significant government support from the Department of Defense. The Reagan administration overcame its ideological objections and approved the project. Thus, an industry-initiated university–industry government collaboration was created at the national level. University research centers such as the Center for Integrated Systems at Stanford, brought together academic and industrial researchers and moved the larger project forward. SEMATECH contributed to the revival of the US industry and later dropped government funding to admit foreign firms and reorganize as an international consortium for pre-competitive research to support the industry as a whole.

These instances exemplify an evolving knowledge and innovation infrastructure that is increasingly constructed from elements of the triple helix. University research centers explicitly adopt industrial models of research management to provide a support framework for academic research groups, balancing these coordination and control elements with research autonomy, including the right of graduate students to have a considerable say in the formulation of research projects through negotiation with their mentor. Similarly, start-up firms are a hybrid creature, embodying academic, industrial and government elements rather than a pure business model even though they are legally constituted as firms.

POLICY FOR INNOVATION

The basic precepts of an 'innovation state' are set forth in a series of propositions about the transformation of traditional state functions to promote innovation:

1. Establishment of legitimate control of violence within a territory, promoting stability and reducing uncertainty as the basis for public authority, is extended from the public to the private sphere.
2. Corollary: Government guarantees are given to private capital so that, with this insurance, it may take greater risks in investing in new ventures.
3. Levying of taxes to support the protection of the nation and promotion of general welfare is extended by using the tax system in a targeted fashion to provide special incentives and benefits.

4. Corollary: R&D tax credits and reduced capital gains taxes are made available to promote innovation.
5. Establishment of rules to structure economic life, including procedures to charter firms and foundations, regulate the conduct of markets and currency systems.
6. Corollary: New agencies are established to promote innovation, including hybrid public/private entities.
7. Use of legal system to establish special rights such as patents as temporary monopolies to promote innovation.
8. Corollary: Universities are granted control of intellectual property rights from government funded research, incentivizing them to become involved in technology transfer and innovation. (US, 1980; Denmark, 2000; Germany, 2002). Universities in Sweden are subsidized through the holding company initiative to encourage them to implement the Third Mission.
9. Provision of basic research funding to establish a linear model of innovation.
10. Corollary: Provision of public venture capital to create an assisted linear model of innovation.

CONCLUSION: TOWARDS A TRIPLE HELIX SOCIETY

Corporatism, the European doctrine of cooperation among government, industry and labor, is reformulated into a 'triple helix' of university–industry–government relations. As a political model of a relatively few institutional spheres in close relationship to each other, corporatism has had democratic and anti-democratic variants. Thus, corporatism has taken social democratic formats in which labor unions and employers' federations play a strong role in negotiating economic and social policy compromises with the state (Crouch, 1993). This is in sharp contrast to fascist formats such as Mussolini's Italy, in which corporatism was a means of bringing industry and labor under the control of the state.

Corporatism is traditionally a pinnacle model that operates from the top down, even when it involves devolution from the center. Devolutionary corporatist formats are typically attempts to activate regions in societies with strong central governments and weak or non-existent regional political authorities. However, in the field of knowledge-based development, corporatist initiatives from below take the form of a quasi-public space that provides a forum for topics as yet of only peripheral interest

to the general political process. Although there is concern that the public sphere is shrinking, an alternative hypothesis is that a new 'quasi-public sphere' is being created in between representative government and private interests.

Creating an organization or network, representing different interests, to build support for a regional focus is a key element in such a strategy. Individuals, typically from the triple helix spheres, come together to brainstorm ideas, formulate initiatives and seek out resources for regional development initiatives in such venues as the Pittsburgh High-tech Council, the Niteroi Technopole in Brazil and the Knowledge Circle of Amsterdam. The New England States formed the New England Council during the 1920s, bringing together industrial, academic and governmental leadership to address the region's long-term economic decline.

A triple helix embedded in a flourishing civil society allows for diverse sources of innovation. Previous governmental foci included regulation of exchange in the market to maintain competition, the manipulation of macro-economic aggregates through monetary policies and redistribution of the results of productivity to redress inequalities (Hirst, 1994; see also Cerny, 1990 for an analysis of the trajectory of state function). An 'assisted linear' model, consisting of a series of organizational mechanisms such as technology transfer offices and programs to explore the practical implications of research, inserted between the producers and users of research, emerged through a series of government initiatives at the national and regional levels. By combining top-down and bottom-up approaches, arising from opposite starting points in laissez faire and statist societies, the promise of the endless frontier is realized.

President, Triple Helix Association (THA)
Editor-in-Chief, *Triple Helix Journal of Innovation and Entrepreneurship*, Springer
Founder and CEO, International Triple Helix Institute (ITHI), Silicon Valley, USA
Visiting Professor, Edinburgh University, and Birkbeck University of London, UK

NOTE

1. Direct state investment in S&T policy remains a relatively small sum in comparison to other sources of R&D spending. Nevertheless, it made a significant, if modest, contribution to the increase in academic R&D from $7 billion in 1980 to $17 billion in 1993 (in 1987 dollars). During the same period industry funding of academic R&D expanded by 265 percent from $334 million in 1980 to $1.2 billion in 1993.

REFERENCES

Benner, M. (2003). The Scandinavian challenge: the future of advanced welfare states in the knowledge economy. *Acta Sociologica*, 46(2): 132–149.
Berglund, D. and Coburn, C. (1995). *Partnerships: A Compendium of State and Federal Cooperative Technology Programs*. Columbus, OH: Batelle.
Berneman, L.P. and Denis, K.A. (1998). Evolution of academic–industry technology transfer in the USA. *Industry and Higher Education*, 12(4): 202–205.
Cerny, P. (1990). *The Changing Architecture of Politics: Structure, Agency and the Future of the State*. London: Sage.
Crouch, C. (1993). *Industrial Relations and European State Traditions*. Oxford: Oxford University Press.
Edquist, O. (2003). Layered science and science policies. *Minerva*, 41: 207–221.
Etzkowitz, H. (2002). *MIT and the Rise of Entrepreneurial Science*. London: Routledge.
Etzkowitz, H. (2008). *The Triple Helix: University–Industry–Government Innovation in Action*. London: Routledge.
Etzkowitz, H., Gulbrandsen, M. and Levitt, J. (2001). *Public Venture Capital*. New York: Aspen/Kluwer.
Etzkowitz, H., De Mello, J. and Almeida, M. (2005). Towards 'meta-innovation' in Brazil: the evolution of the incubator and the emergence of a triple helix. *Research Policy*, 34(4): 411–424.
Greyson, L. (2002). Give us back our regions. *Innovation Policy Review*, 4(2): 1.
Hirst, P. (1994). *Associative Democracy: New Forms of Economic and Social Governance*. Cambridge: Polity Press.
Jessop, B. (2002). *The Future of the Capitalist State*. Cambridge: Polity Press.
Mirskaya, E. and Rabkin, Y. (2004). Russian academic scientists in the first post-Soviet decade: empirical study. *Science and Public Policy*, 31(1): 2–14.
Stanco, T. (2004) Start-up discussions, George Washington University techno-l 180604.
Walshok, M. (1995). *Knowledge without Boundaries*. San Francisco: Jossey Bass.