

Strand A, Theme 3

Overall performance of the Triple Helix Approach:
from efficiency of factors of production to ‘modes of coordination’

The triple helix concept: toward the formation of a new social system

Alain-Marc Rieu

Professor, University of Lyon-Jean Moulin
Senior researcher, Institute of East-Asian Studies (CNRS), ENS Lyon
<amrieu@gmail.com / <http://w7.ens-lyon.fr/amrieu/>>

Professor of contemporary philosophy and Science Studies at the University of Lyon–Jean Moulin and senior research fellow at the Institute of East Asian Studies at the Ecole Normale Supérieure de Lyon. He is studying the mutation of the role, conception and organization of knowledge in advanced industrial societies in relation to the present systemic crisis and growing environmental constraints. In this context, the Triple Helix model is reconfiguring established demarcations between human and social sciences and opening new conceptualization of social-economic systems.

Abstract

The pertinence and strength of “triple helix” model was and still is to explain the institutional arrangement at the core of a “national system of innovation. These two models have always been closely related but they are also divergent projects. The “national system of innovation” model is older: it has always insisted on close cooperation between these three poles under the guidance of an administration managing the coherence economic growth and social progress, based on cohesive research and innovation policies. The “Triple helix” model is stressing the relative autonomy of the three poles shaping the economic evolution of a social system and its global

economic competitiveness. The model is stressing the need for constant negotiation and adjustment between these three poles. These two powerful models express different historical moments. The triple helix model is major conceptual and institutional innovation, leading to the formation of different type of social-economy system. The problem today is to evaluate what is this social-economic system, how does it innovate in providing answers to the present systemic crisis in mature industrial societies and responses to intensified environmental constraints.

Keywords: triple helix, environmental constraints, research and innovation policies, innovation, evolutionary social systems.

1. Just a concept

The “Triple helix” (TH) is just a concept, a metaphor turned into an idea, a typical “ideal-type”, a project and a program at the sale time. During the last 20 years, this idea has been endlessly researched and theorized, constantly debated and questioned. There is no real empirical evidence that it could ever been applied but it has influenced strong policies and inspired fruitful debates in many countries¹. This concept has now become a common problem and issue in all industrial societies. In 2013, the problem is to research and debate the role it can play in the present systemic crisis.

The present crisis is systemic because, since 2007, it is successively and simultaneously financial, economical, social, monetary, political and even geopolitical. But it is also systemic because of its background: first the globalization process and its multiple consequences, secondly the energy crisis and global warming prove the irreversible transformation of interactions between social-economic systems and their biophysical environment. The Triple Helix concept (THC) still plays a major role in the diagnosis and in

¹ For instance, the report *Bridging the valley of death : improving the commercialisation of research* (London, Science and technology committee, House of Commons, March 2013) is strongly influenced by the Triple helix model and its related debates, for instance the “ecosystem of innovation” p 11.

the cure: until today research and innovation are expected to provide responses to these challenges, with a clear understanding that the institutions and processes involved need to adapt to this context. The Triple helix might be just a concept but it is still a corner stone and a conceptual platform for research and debate. It is both an end point and a starting point. The present systemic crisis has transformed the context in which this concept emerged. But because of its role as platform for research, policy and debate, it is important to evaluate how this concept can be redesign in order to integrate two problems which cannot anymore be ignored: the place and role of “society” in the TH arrangement, the constraints on social-economic systems of the biophysical environment.

This paper stands at this conceptual level. Of course it cannot pretend to conceptualize adequately such intricate issues. It is aware of the many case studies and quantitative analyses that have been made in the last twenty years. These data and issues put the THC to test. But questioning the concept seems, for the moment at least, the only access to another model. My goal is simply to participate in this investigation. There are many ways to question today this concept, to evaluate what it teaches on the present situation. Because of its deep inscription within the evolution of advanced industrial societies, one solution is to put THC in different perspectives. THC is often considered from the point of view of one helix on the other two, in order to see how their interactions can be more fruitful. My approach is to view the interactions between universities, government and industry from the point of view of the social system in which they grow and interact. It is also to view the social system from the point of interaction between the three helixes.

2. Context of emergence: the first energy crisis in the 1970s

It needs to be endlessly stressed that the initial event at the source of the evolution transforming industrial societies and economies, the conditions of their evolution and the

world order, is the first crisis of energy and natural resources, which first erupted in 1973 and lasted until 1982. In forty years, this energy crisis developed into a global environmental constraint on all societies. This crisis was much deeper than a question of increased cost and free access: it touched the core of each industrial society, their infra-system, which holds together the social and economic system. In retrospect, it has become clear that since the end of the 19th century and certainly after 1945, industrial economies could develop and grow only by controlling the cost and availability of energy and natural resources. The worldwide control of cost, access and transport of natural resources has been the basis of the development of each industrial society. Companies could make profits because of steady and strong demand based on a high level of employment and consumption as well as various social programs financed by taxes on profits, incomes and consumption. A comprehensive State and its bureaucracy were managing the system. Welfare state, consumer society and market-based social capitalism are variations of the same system. The basic competitive adjustment variable was the cost of energy and open access to natural resources. This cost expressed the need for capitalist societies to sustain trade and industry in order to create jobs, to stimulate demand and preserve social stability. Managing such a system required a skilled and broad administration. The energy and raw materials crisis of the 1970s was the moment when the core-system of the “free world”, of all industrial nations under American military, industrial and technological hegemony, was destabilized and started deconstructing. Growing environmental constraints have intensified this deconstruction.

The response to this energy crisis differed from nations to nations. But each nations and government, each economy and each company had to face the same problem: the rising cost of energy and raw materials was increasing production costs, reducing competitiveness and intensifying international competition. The second common problem was to decide how

much those increased production costs could be translated into increased prices on the market. In all industrial nations, the economic crisis induced by rising energy costs was reinforcing competition and this competition soon became destructive: in the late 1970s, companies were starting to close, unemployment was rising, taxes were bringing less revenue, social policies were starting to show important deficits. In order to remain competitive, companies and industries had to imagine how to reduce costs without reducing consumption and demand.

Since the late 1970s and early 1980s, there was clearly three ways to sustain competitiveness and they have been implemented by each industrial nation. The first solution was to stall and even lower salaries, the second solution was to reduce employment. The third solution was to reduce the cost of bureaucracy, of State and government administration in order to lower taxes, either taxes on citizens in order to strengthen demands, savings and investment, or taxes on businesses and profits. This third solution included reducing social programs and benefits: education, health, security and pensions. But there was also a fourth solution: to invest massively in science and technology so that innovation could create new products and services, restore competitiveness, create new industries, industrial and commercial processes, which would reduce dependency on natural resources, alleviate environmental constraints (pollution, global warming, energy shortages, speculation) and increase productivity in order to neutralize energy costs. This fourth solution is based on various models, policies and theories². Until today, industrial nations have not found any other solutions and have not been able to implement successfully any alternative response³.

² See Benoît Godin's work available at <http://www.csiic.ca/>. See in particular "The Linear model of innovation: the historical construction of an analytic framework" (*Science, technology and human values*, Sage Publications, vol. 31, n° 6, November 2008, p 639-667) and "National innovation system: the system approach in historical perspective" (*Science, technology and human values*, Sage Publications, vol. 34, n° 4, July 2009, p 476-501).

³ This explains the utopia of discovering the inexhaustible clean source of energy, the last one being the international ITER program being built in the South of France.

3. Conceptual response: from NIS to THC

In retrospect today, one can identify two systemic responses to this disruption:

- Neo-liberal policies conceived and implemented since the early 1980s first in the US and then in the rest of world,
- Large-scale Science & Technology policies conceived and implemented in Japan since the early 1980s and until today.

Both responses are sets of theories and policies, which have never been separated by a “Chinese wall”. But they have quite different sources, histories and consequences. They also require different institutional arrangements and generate different economic, social and cultural evolutions. Most important, they are tacitly competing with each other. Until now, nearly all policies designed to overcome the crisis, which emerged have been versions of neo-liberal policies. At the same time, variations of the Science & Technology policy model are implemented today by most industrial nations, including China and since 2010 by the US themselves. The Triple helix concept took shape in this context and it tends to blur, to deny or overcome the divergence between these two policy models, which is not seen, for the moment at least, as leading to a contradiction. Science and technology policies designed in the US have different sources, institutional background and impact than the model designed by Japan’s techno-structure since the early 1980s.

The Research and Innovation paradigm was the diagnosis, the response and the cure designed in the mid-1970s by Japan’s techno-structure. The energy crisis and the rising cost of all raw materials from 1973 to 1978 and 1982 were undermining the fundamentals of a Japan’s economy, rebuilt with difficult and effort after 1945. Japan was importing nearly all its energy and raw materials. The shock was intense: it did not only concerned energy and the economy. The threat was considered as serious for Japan’s sovereignty than the threat of

colonization in the mid-19th century. The response to the crisis was organized and managed by the celebrated MITI (Ministry of International Trade and Industry) in close cooperation with the major industrial, commercial firms as well as universities and “national laboratories”. In the early 1980s, this response was considered a success. In a few years, the Japanese economy had gone through an industrial and technological mutation: its dependency on imported energy and raw materials had been controlled by a major increase in productivity based on automation.

This reorientation and reorganization of Japan’s economy had long-term consequences, lasting until today. The initial strategy was a progressive conversion of all industries toward productions of higher added value and new industrial processes. Such a coordinated strategy could only be conceived and achieved by an institutional environment organized around a powerful State administration. In the early 1980s, Japan’s techno-structure had responded to the crisis by establishing an endogenous dynamics of great intensity and success. This “virtuous cycle” was the core of Japan’s economic growth in the early 1980s. It was also the core of Japan’s economic resilience after the 1985 *endaka*, this abrupt rise of the Yen decided by the G5 in order to curb and control Japanese competitiveness. A new paradigm had been invented in Japan⁴: to respond to increased environmental constraints and economic competition by organizing a “high added value” economy based not on science and technology but on Research and Innovation. This paradigm implies quite a different institutional environment and policy matrix than Neo-liberalism.

⁴ Sakaiya Taichi explicitly formulated this paradigm in his book *The Knowledge value Revolution* (Tokyo, Kodensha International, 1991). Books by Kodama Fumio were also very influential: *Analyzing Japanese high technologies: the techno-paradigm shift*, (London, Thomson Learning, 1991) and *Emerging patterns of innovation: sources of Japan’s technological edge*, (Cambridge, Harvard University Press). For a clear synthesis, see Gregory Tassej, “Towards an integrated technology-based strategy” in *Strategies for a technology based competition*, Lexington, Lexington Books, 1987, in particular p 125-134.

In the late 1980s, some British economists and sociologists like Christopher Freeman⁵ and Martin Fransman⁶ were in Japan studying how Japan had succeeded in a few years to transform the latest technological wave, computer science and electronics, into a set of new industries and services. According to their diagnosis, a new type of industrial policy, of a different scale, had been created and a new model for organizing and managing industrial societies was born. The concept of “national system of innovation” (NSI) was invented at that time in order to describe how universities, government agencies and business firms could be associated in a coherent institutional arrangement in order to coordinate research, investment, innovation and production with the goal to stimulate economic growth and social progress. This institutional arrangement is a decisive, *Schumpeterian*, innovation in the evolution of advanced industrial societies⁷. Since the 1990s, this powerful theory led in each industrial nation to the conception and implementation of large-scale research policies, competing and collaborating with each other at the same time (Rieu, 2008).

Even if it existed before, as Benoît Godin explains, the Triple Helix concept was formulated *after* the concept of “National innovation system”. Its intent was to formulate the institutional arrangement acting as the working core of a “national system of innovation”. The researchers, who constructed THC, defined the basic components and partners of such a system: universities, government, and industry. It is just a concept but this concept has a strong power because it rationalizes and explains how a “National system of innovation” works, what it does and how it should be organized. But the real power of the model comes also from the fact that the concept of NSI is itself a conceptual response to the disruptive event, which since the 1970s is deconstructing social-economic systems established in mature

⁵ Freeman Ch (1987) *Technology Policy and Economic Performance: Lessons from Japan*. Pinter Publisher Ltd, London. (1988) *Japan: a new national innovation system?*. In: Dosi G, Freeman Ch, Nelson R R, Silverberg G and Soete L (eds.), *Technology and economy theory*, Pinter, London

⁶ Fransman M (1990) *The market and beyond: cooperation and competition in Information Technology development in the Japanese System*. Cambridge University Press, Cambridge, *Visions of innovation. The firm and Japan*, Oxford, Oxford University Press, 1999.

⁷ It is also a response and alternative to neo-liberalism. See Rieu (2011).

industrial nations after 1945. Together these three components constitute a virtual institutional arrangement, informal but effective, which is supposed to lead and organize the social-economic system. These two virtual institutional arrangements, NIS and THC, are a conceptual response to the disruptive event at the source of the present systemic crisis. But there is a real conceptual progress between the two. The NSI implies that a State or government agency could and should organize and lead this system. This indicates clearly that NSI is an advanced and reformed type of industrial policy. This type of policy is succeeding both to the “development state model” described by Chalmers Johnson⁸ and to the post-war “reconstruction state model” in Japan as well as Europe after World War 2. It is a typical social-democratic model: the role of government does not fit a neo-liberal perspective.

The Triple helix concept is a link in the chain of progress in the social, economic and political response to the energy crisis, itself forerunner of present environmental constraints and of the present systemic crisis. THC supposes and explains that government is just one helix of the three. Of course government, universities and industries have to collaborate and find the means to do so. But government should remain independent from universities and industries. As a helix, government should not try to lead and coordinate the two other helixes. The strength of the THC is to assert that each helix, each sector, sphere or function of the social-economic system has its own logic of development and organization. Each sphere is self-organized: it produces knowledge on itself, on the other spheres and on the social-economic system itself. This auto-organization or self-reflective process, whatever the name, is establishing the autonomy of this sphere. Of course this autonomy is never fully achieved and a social sphere is never independent of the social system itself. But it has its own requirements and standards. This explains the power of THC, the power of a concept naming a virtual state in a social-economic dynamics. However abstract it might be, it indicates an

⁸ *MITI and the Japanese miracle. The growth of industrial policy, 1925-1975*, Stanford, Stanford University Press, 1982.

effective evolution of social-economic system in advanced industrial (or mature) societies. It raises of course many difficult and theoretical problems, which seem purely rhetorical for many, but which are real issues. The main issue concerns the practical coherence and management of an arrangement where government is just a specialized sphere of activity, with its own responsibilities, but which should not infringe on the two other spheres and their own logic, their own internal evolution with this system. The question is not: who governs? But: who regulates? How a regulation is done? The obvious answer is in constant tensions, negotiations and debates. But this answer remains open and insufficient. An end point is reached; the problem is to transform it into another starting point.

Apparently THC participates in the neo-liberal paradigm because it asks for a high degree of autonomy of each specialized sphere and because consequently it recognizes a high degree of autonomy of the economy in relation to politics and society. But at the same time, THC does not suppose that the economic sphere should be dominant or that its method, criteria and models should dominate the other spheres. On the contrary, this is explicitly what THC rejects as false and wrong. THC requires coordination, collaboration and adjustment between these different autonomous spheres. It does not explain how. From this point of view, THC is clearly beyond neo-liberal theories and policies. The problem is that we don't really know where we are, what is sort of social-economic system is emerging under the umbrella of this theoretical THC. At the same, I hope to have made clear that THC is not an invention but the outcome of reflective process embedded in the evolution of advances industrial societies since the energy crisis. From my point of view, the growing biophysical constraints on social-economic system are leading and pushing in this direction. Writing these last sentences, I understand that I touch the present evolution of our societies in Europe, Japan and even North America. But I understand also that I reach the limit of what is known or what I know.

In summary, the pertinence of triple helix model was and still is to explain the core institutional arrangement of a “national system of innovation”. From the beginning, these two models have been closely related but they are also divergent social, political and economic projects. The NSI concept was stressing close cooperation between industrial firms, government and universities under the guidance of an administration managing their coherence and shaping the economic evolution of the social system. This public agency had for goal to organize and manage cohesive research and innovation policies. The THC is stressing the autonomy of each pole and the need for constant negotiation and adjustment between these three poles. It was and it remains a method to analyze a “national system of innovation” as well as a method to establish and manage such a system or to reform an existing one. Both models were from the beginning a “prospective description”, both a description and a prescription. They *work* inside one another. As such both models were and remain a typical Schumpeterian “creative innovation”. This means that the model is not fixed and never fully established. It remains an open debate and object of research.

4. The Triple helix arrangement from the point of an evolutionary anthropology

This clarification being done, what is the next step? Where to find it? The main problem raised by THC is its basic assertion: a social-economic system *is* (should be) driven by interactions between three autonomous spheres having their own *logic*. This relative autonomy between these spheres as well as the continuing negotiations and tensions between these spheres, generate innovation and the transfer of these innovations between the spheres with the expected outcome of increased competitiveness, economic growth and social progress. It is metaphysics. This concept, its meaning and function, are outside economics, sociology and political science, even if they intersects these three disciplines. My interest

focuses on this intersection. THC has for goal to associate three autonomous spheres into a dynamic and coherent *virtual* institutional arrangement (*dispositif*). Two obvious problems arise: what are the relations between these three spheres with the rest of “society”, with the other components of this social system? How THC integrates the growing impact of biophysical environment in which this social system grows, from which it extracts its energy and natural resources, where it stores the waste produced in this process. The problem is to examine if THC reproduces the common divide between “society” and “nature” or if it is able to overcome this conceptual divide. This question stands outside economics, sociology and political science but it stands at their intersection. This question could be denied until the 1980s and 1990s: it cannot today. In order to sort out these various problems raised by THC, theoretical progress is required. One way, among many others, is to address these problems in a different perspective, from the point of view of an *evolutionary anthropology*.

This anthropology is a construction. It aggregates different schools of thought, from Marcel Mauss and his “economy of gift⁹” to Niklas Luhmann¹⁰ and his analysis of society derived from system theory. In this conceptual framework, a social system is constituted of different sectors, spheres or functions. These functions are supposed to be observed in all societies. What differs from society to society is their level of differentiation, aggregation and interaction. These functions are the following:

- The “religious”, religions and their institutions, including churches and their role in different societies;
- The State apparatus and government;

⁹ “Essai sur le don”, *Sociologie et anthropologie*, Paris, P.U.F., 1950. The famous “Essai sur le don” is a study of a type of economy or economic exchange. Marcel Mauss studied the tradition of *potlatch* in different societies. *Potlatch* was the name in North-West Pacific native societies of a type of exchange, the goal of which was not to accumulate wealth but to accumulate prestige and recognition by giving “freely” to various groups within the tribe or to the tribe itself. To give a good without exchange was reinforcing and establishing hierarchies within this society.

¹⁰ See William Raasch, *Niklas Luhmann's Modernity: the paradoxes of differentiation*, Stanford, Stanford University Press, 2001.

- Society, both in the sense of the population, the people, “civil society”, individual attitudes and collective behaviors;
- The economy and markets, their commercial and industrial networks, etc.

In the societies studied by Marcel Mauss, these functions were built into the one another with a low level of differentiation. Government was reduced to the hierarchy of clans and families ordering the social system. The economy did not exist beyond exchanges between families. The “economy of gift” was also ordering society, reproducing hierarchies between clans and family and also redistributing (even destroying) accumulated goods, which could endanger established hierarchies. This redistribution practices were establishing a type of governance acting as a substitute for a formal government. There was no distinct “market” because exchanges did not differ from relations between clans and families. Religion itself was embedded within the social system and its inscription in its natural environment. By comparison, in medieval societies in Europe, religion and the church were considered an expression of god in his creation and the ground of the collective order of humanity and its activities. Religion and politics were closely intertwined. The population had no autonomy because people were considered subjects of the church and of the king in a structure of society dictated by the sacred order of creation. Individuals viewed their lives and duties from the point of view of the Church and the kingdom, according to their place and role in this social system. In this system, knowledge activities were fully embedded within the social system and within the symbolic and theological structure of the cosmos, the world and society.

We can all agree with this minimalist but standard narrative. Modernization is the name given to the process, which in a few centuries transformed Europe like a virus and the rest of the world by adopting or rejecting this virus. This process is extremely complicated in its historical details. But, from a long-term anthropological perspective, it is rather simple,

even if the devil is indeed in the details. *Modernization* is the name given to a progressive differentiation of these functions and the resulting transformation of these functions and their interactions within the various social systems. At a certain level, this differentiation gives these functions a growing specialization and autonomy. Two principles can be inferred from this differentiation process:

- When a given function reaches a certain degree of autonomy, it develops its own logic and this *autonomization* leads to a rapid growth and the self-organization of this function;

- The *autonomization* of a function transforms the social system itself by reshaping the interactions between these functions and the functions themselves.

Within this theoretical framework, underneath historical events, the evolution of European nations is analyzed as a growing differentiation leading to a series of successive scissions. Each scission originated in a specific location and a given religious, cultural and social context. These scissions spread in different parts of Europe and were replicated according to local contexts. This process explains the diversity of European modernization trajectories. The first scission is probably the most important and difficult one. It is the progressive divide and final rupture during the *Renaissance*¹¹ between the religious and the political, between the Church and political power. This scission gave rise to the modern conceptions of politics establishing its own legitimacy and institutions independently from the Church. It took the shape of the “absolute State”, of a State religion, of a political control of religious institutions, etc. In Great Britain, the king Henry the VIII is a typical example of this scission. This scission opened disorders and tensions as well as major innovations in many different fields, in politics and political philosophy but also in science and knowledge in

¹¹ *Renaissance* is the name given to the final moment of this initial differentiation.

general, including the formation of new institutions dedicated to science and technology under the control of the modern state.

Most importantly for the present argument, this first and decisive scission opened the possibility for further scissions as early as late 17^o century. They are well known: they have driven European development until today and took around three hundred years to produce their full effects. The second major differentiation is the decoupling between the political and the social. It gave rise to the idea of a “civil society”, to the collective experience that individuals and groups existed by themselves outside the State. Based on this experience, they could imagine they were selecting their own government, that they could evaluate and control existing governments. A third scission took shape within this second one. It had and still has major consequences: it is a progressive dissociation within “society” between the people or population and commercial or economic activities. The economic sphere became during the 18^o century increasingly *autonomized*. Its own *logic*, its concepts, problems and rationality were formulated in a new field of study, political economy. The emergence of a specialized field of knowledge reinforced its autonomy and reformulated its relations to society, politics and religion. This *autonomized* sector within the social system is called commonly capitalism or market capitalism. Until today, Euro-American societies understand themselves, debate their present and future within this series of scissions, which started and unfolded since the 16^o century. These scissions determined this evolutionary trajectory of each nation, the structure of our societies, the role of the individuals in them, the relations between all of them¹². The globalization process is largely an extension of this process.

What is missing in this theory is the source of the initial rupture. There are many causes but the trigger is the mutation of the conception, organization and role of knowledge

¹² This theory of modernization is based on three historical experiences: a function never achieves a full autonomy; it always remains embedded in a social system; no dissociation is forever: regression and reinterpretation are always possible.

activities from the Renaissance to the 17th and 18th century: the formation, rise and institutionalization of “modern science”, what is commonly called the “Copernican revolution”. Knowledge activities were so deeply embedded in the social system that mutation and progress in these activities were reshaping the social system. The institutional control by the State proves that knowledge activities were considered strategic: it exhibited the glory of the king but it also provided the instruments of its economic and military power. In the case of France, from the early 19th century, under the guidance of Jean-Antoine Chaptal¹³, the industrialization of modern science was the source of France’s first industrial revolution. Other examples abound in all Western European nations. What is important is that science and technology and other knowledge activities were early on considered in Europe the source and condition of national wealth and power, of long-term economic and social progress. Because of its strategic importance as well as its long-term economic impact, scientific research considered “basic” or “generic”, remained in many countries a state monopoly and under the financial control of the State.

5. From the Triple helix arrangement to the epistemic sphere

The Triple helix concept, its virtual institutional arrangement, is clarified when situated with such conceptual frame and evolutionary approach. It clarifies some debates and opens new ones. It concerns the conception, organization and role of knowledge activities in advanced industrial societies and it concerns directly, from my point of view, the present systemic crisis.

A decisive evolution started outside Europe, in the US, during the World War 2 and was reinforced after 1945 when science and technological research were considered the

¹³ "L'ancien régime et l'industrialisation: mutation et innovation selon Chaptal", *Innovations et nouveaux techniques*, Strasbourg, Presses universitaires de Strasbourg, 1989, p 281-302. <http://hal.archives-ouvertes.fr/hal-00741546>

source of long-term economic and social progress as well as military dominance. In this context, major institutional reforms were designed and implemented. The main one concerned universities, which became according to Clark Kerr¹⁴, Chancellor of the University of California, Berkeley, in the early 1960s, “knowledge industries”. This conception of the university and related reforms are exactly those, which constituted universities as a full helix in THC, and which also changed the relations with government and the entire economy. This long-term evolution is not yet fully achieved and understood. It faced from the beginning strong resistance. The decisive moment in this long-term evolution is not national security: the Bayh-Dole Act of 1980 proves national security was considered in the 1970s a hindrance to innovation. It is the energy crisis, which erupted in 1973 as the forerunner of ecological transition.

At this point, I return to the beginning of this paper, to the Japanese response to the energy crisis of the 1970s as British economists and sociologists¹⁵ interpreted it, to those researchers, who invented the concept of “National Innovation System”. I return also to the formation in the 1990s of the “triple helix” concept by Henry Etzkowitz and Loet Leydesdorff¹⁶, repeatedly argued and explained according to various contexts and issues. In their context of emergence, namely the energy crisis, and in a long-term perspective, these concepts indicate a major epistemic turn: science and technology, their institutions, were now considered the drivers of economic growth and social progress. At this stage of the modernization process, in this type of societies, science and technology were considered and became the infrastructure of the social-economic system. What was deeply embedded in these social systems became the core of these new social-economic systems. I diagnose this

¹⁴ Clark Kerr, *The Uses of the University*, Cambridge, Harvard University Press, 1963, 5th edition. 2001.

¹⁵ They were members of the *Science Policy Research Unit* (SPRU) at the University of Sussex at Brighton.

¹⁶ Their report “Emergence of a Triple Helix of University-Industry-Government relations”, (Report of the Conference in Amsterdam, 3-6 January 1996, www.leydesdorff.net/th1a/) traces shortly the historical formation of this concept in order to evaluate the difference between national research policies (p 4-5). This perspective of the THC has a different goal from present one. By stressing the link between the two main models, NSI and THC, my goal is show the emergence of a new specialized and autonomous sphere of activities.

mutation as the *epistemic turn of advanced industrial societies*. Its main consequence has been the conception and implementation since the 1990s of science and technology policies of increased scale in Japan, the US and in the European Union. This epistemic turn was reinforced in the mid-2000s when global warming and rising costs of energy became a major threat to economic growth and it was further reinforced since the systemic crisis erupted in 2007.

From an evolutionary point of view, this epistemic turn is the emergence of a different social and economic system and a new step in the evolution of industrial societies. It received different names: from “high value-added society” in Japan in the early 1990s to “new economy” and “knowledge society¹⁷”. Its requirements and consequences are not yet fully studied and evaluated. An obvious proof of this mutation of the conception and role of knowledge activities is the *retreat* of the opposition between science and technology to the distinction between research and innovation, which tends to focus on the processes linking the two. The main character of this emerging social system is that knowledge activities have become an *autonomized* and specialized sphere of activity. From this point of view, the Triple Helix concept marks the formation of this specific function: it identifies its components: universities, government and industry. This *epistemic sphere*, like others before, has its own logic and requirements. But in order for its autonomy to be recognized and its institutionalization established, its various intricate parameters need to be first researched and debated. But this epistemic sphere is building its autonomy but it does not have yet a full and proper social science, outside economics, sociology and political science, at their intersection. But in order to recognize its autonomy leading to its eventual progressive institutionalization, its various parameters need to be first researched and debated. This is the reason why THC is

¹⁷ These different notions were in fact naming different state of affairs and evolutions. See Rieu, “What is Knowledge Society?”, *STS Nexus*, Santa Clara University, Center for Science, Technology and Society, San Jose, September 2005. <http://halshs.archives-ouvertes.fr/halshs-00552293/fr/>

an end point as well as a starting point. It indicates and performs the transition toward a different social-economic system.

At least one point is clear: the emergence of an autonomous epistemic sphere challenges established power relations within the social-economy system. If industries and universities see their benefits, the State bureaucracy understands that its traditional control over knowledge production is radically questioned. Genuine institutional reform was extremely difficult in Japan in the 1990s and even more so today in France until today. The State bureaucracy is incapable of adapting to this evolution even if it understands its source and consequences. This transfer of power to research (indeed, to knowledge in general) is a genuine threat to the established power equilibrium. The historical competence of the bureaucracy deserves to be recognized, but ministerial administrators cannot pretend to control the research activities they have to finance. It is of course difficult for a bureaucracy to recognize its limits and to organize its own overcoming.

In this new context where Research & Innovation have become an *autonomized* sphere of activities within a social-economic system in a state of reconstruction, government does not designate anymore the State apparatus, which historically controlled knowledge production and distribution. According to THC, “government” means Research & Innovation becomes a full political process and these political choices are expressed in policies. As mentioned before, what is relevant in THC is not only that it identifies three specific types of activities and institutions but also that it designates and establishes a virtual arrangement between these three independent fields. This arrangement is thought in terms of *governance*, not government, in terms of coordination, adjustment, negotiation or collaboration. Nobody really knows yet how to operate this coordination: a “spontaneous” arrangement or an *emerging* coherence are of little meaning considering powerful fields of activity driving the evolution of societies. But the same evolutionary perspective shows that THC expresses the

autonomization of research and innovation activities, the epistemic sphere but also its connections with the other spheres, with politics, society, the economy and even religion or “spirituality”. I have explained before that all progress in the differentiation of the social system, in its different spheres reshapes each function and transforms also their connections and interactions. From this point of view, THC effectively designates new types of coordination and interaction between these specialized spheres. But it just gives a name to a problem without providing real solutions and without providing even a profile of this new type of social system THC helped to identify.

Finally, an anthropological and evolutionary point of view shows that the formation of a specialized sphere within the social system gave birth each time to a new body of knowledge, a philosophy, human and social science. History proves that this body of knowledge played each time a major role in the *autonomization* of this specialized sphere. The work of Machiavelli (or later Spinoza) expressed the emancipation of politics from religion. It even defined the logic of political action, of political institutions and political power. The scission between the State and society was expressed and also performed by the philosophy of government and civil society formulated by Locke, Hume, Rousseau, Kant and many others. The scission between society and the economy gave birth in the end of the 17th century and all along the 18th century to political economy, which provided in the late 18th century the concept and method to (partly) describe and manage the coming industrial revolution. The destructive impact of the industrial revolution on societies and cultures was the source of sociology as well as Marxism. But in this perspective, recent disciplines like economics of knowledge, sociology of knowledge and technology management seem to be projections of existing disciplines on their respective fields of study. But they do not fully address the growing autonomy of knowledge activities. They do not to properly or fully express the mutation of the conception, organization and role of knowledge activities in the

present evolution of societies. By comparison, NSI and THC open a specific field of research. I only hope to have profiled this new field and to contribute to its emergence.

6. Next steps. THC and biophysical constraints on social-economic systems

Three remarks to conclude. First the project in the early 2000s of adding “society” as a fourth helix seems now superfluous. It is a fact that interactions between universities, government and industries seem to deny the existence and role of individuals and groups, of their values and culture, their needs and desires, in the social system. It becomes a system without society. It supposes that individuals can be reduced to users and consumers. It is just an extension of economics. Adding “society” as a fourth helix intends to prove that individuals and groups constitute an autonomous entity between universities, government and the economy, with their own values and interests, with their multiple cultures and diversity of attitudes and behaviors. Further more a social system cannot be reduced to these three functions and their interactions. But societies cannot also be reduced to what perturbs, hinders or facilitates interactions between these three helixes, to what is *in between* to mediate and coordinate. This is certainly a description of the role society plays or can play but it does not explain what is *in between*, what it does or does not do. In this conception, “society” is considered from the point of view of each helix and from the point of view of the triple helix. It is the other way around: society is the *milieu* in which universities, companies, the State apparatus and government are embedded. They are types of institution within a social system. Society cannot be reduced to individuals and groups, *plus* what they have in common, reduced as usual to history, culture, values and institutions. Society is first a collective and daily experience, secondly a social system studied by human and social sciences. Universities, industrial and commercial activities, political institutions and regimes are historical

constructions *in* the social system and *of* the social system. In summary, the social system is first, including the knowledge it produces on itself.

The second remark concerns the present systemic crisis and its destructive impact on the industrial nations at the source of the industrialization process, mainly European nations and Japan, including Canada and the US, even if the US refuse to admit it. One should probably add South Korea. These nations are those where science and technology traditions, institutions and training are often quite strong. The emergence in these nations of research and innovation as a full autonomous field of activities might lead to new industries and renewed competitiveness. This evolution would require major institutional reforms, which some nations might not be ready to undertake.

The third remark concerns my starting point and first assertion: the disruption introduced by the growing pressure of the biophysical environment. If THC is a sort of conceptual frontier in our present understanding of the evolution of industrial societies, the problem is to decide if THC gives clues and opens doors to internalize the environmental constrain into the present analysis of industrial social systems or if it is adverse to such progress. In the later case, THC would have become an epistemic obstacle. My hypothesis is that THC can be reformulated and can provide a theoretical transition. Such conceptual experiment is beyond the scope of the present paper.