Seeking University-Industry Balance

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Introduction

The relationship between university and industry is becoming more and more important. A proper amalgam of the different and at times conflicting objectives can bring long range benefits. By contrast, disconcerted actions while possibly leading to short term but incongruous advantages is surely a source of long range damage. Such critical circumstances appear unprecedented: only few years ago the fortunes of universities and industries seemed almost totally disconnected. Only a few researchers paid any attention to particular facets of this issue and their analysis seemed mainly speculative studies. Essentially, the process of wealth generation was only weakly related to the process of knowledge production. In reality, the former has always been a consequence of the latter, but the temporal separation of the two processes meant that other parameters, such as control of (conventional) raw materials, political supremacy, and monopolistic dominance of the market, attenuated possible university-industry mismatches.

The key issue is that the university satisfied needs for erudition while industry answers to the demands of capital. These different objectives lead to what Dasgupta and David [1] term “the realm of technology” (industry) and the “republic of science” (university). Nevertheless, the objectives of university and of industry are not conflicting by definition. Specific requisites for cultural development coincide with the ones of capital; conversely, broad needs of industry coincide with broad objectives of university. Important examples of common contact points are the employment issue and the nurturing of social wealth for future generations. The difficulty of the problem consists in finding the right balance between the “realm of technology” and the “republic of science” ensuring reciprocal respect and mutual benefits. The point is that both should refer to the needs of society: whether economical, cultural, technological or social. The balance is difficult to identify and more difficult to realise and maintain. It requires a deep understanding of the issue and significant managerial ability.

This paper discusses various aspects that, at a first glance, seem disconnected. Nevertheless, I think that we have to globally account for diverse elements if we want to address a difficult issue properly. We are facing a big change: we have left industrial society and we are entering knowledge society. In the past we had conflicting ethical priorities between universities and industries which produced distorted attitudes calling for prompt corrections. Motivation is another important element that needs some analysis. Moreover, the behaviour and role of managers demands attention. Finally, we should account for the impact of public funding policies. All these ingredients influence any possible solutions. As we will see, this paper is not going to hold up a definitive recipe and what it will suggest certainly need correction and refinement. However, (hopefully) it will establish a reasonable starting point.

The Changing Scenario

Many say that the advantage some societies have over others derives from the availability of raw materials: having raw material is essential for producing goods, which constitute, in essence, a suitable transformation of primary elements into outcomes. But raw materials are not only what we conventionally define them to be: wood, copper, aluminium or salt. They are more generally the basic components of productive transformations. If we consider low-tech production its basis is certainly given by the conventional raw materials but we have not to forget that labour is another essential component. Therefore, it is probably a mistake to distinguish between row materials and labour: both are basic components (therefore, they are raw materials) since their use allows us to generate goods.

The evolution over the past century has lead to conventional raw material becoming less important and new elements contributing much more efficiently to production flows. Managing the production processes was the key to success in the last century: Henry Ford invented the assembly line and the efficiency of car factories was increased by one order of magnitude. Thus, we could infer that Henry

Ford discovered a new raw material: the assembly line method. Before its creation and codification the assembly line was like the tomato that was not available until Colombo discovered the Americas. In a sense, the production process represents, for assembly cars, a newly discovered raw material, much like the tomato that made pizza possible after the year 1492.

More recently technological processes have further increased the effectiveness of productive systems. Some conventional raw materials and, in some cases, new elements that were never considered as such, have been reshaped and became new raw materials. For example blending iron and carbon has given us steel, with oil we have produced plastic, with silicon (common sand) we have made integrated circuits. Hence, new raw materials have emerged and are now available for productive processes. However, the introduction of new raw materials was made possible by a proper application of the brain. In this sense, the brain has become an essential component of productive transformation and has wrought a fundamental change to role which constitute a dichotomy: at the same time it is a raw material and an engine for the transformation of raw components into products.

The key point is use of the brain and its product: knowledge. When knowledge is codified, that is reduced and converted for easy storage, reproduced at low cost, verified and transferred, we have deployed a new form of raw material. Coded information becomes equivalent to a "commodity" that, combined with other essential components, contributes to industrial products. What makes this new variety of raw materials possible is "information technology". Knowledge is codified into messages and communicated to possible users; messages with a given "information content" (limited by an extension of the Shannon theorem) are a new form of "raw material" befitting the knowledge society.

Thus, codified knowledge can be regarded as a "raw component" while the non-codified (or tacit) intelligence, which is the brain activity capable of creating "wealth", belongs to the sphere of skill in assembling raw materials and originating new products. The above distinctions are evolving in time. At its beginning the assembly line method corresponded to the tacit knowledge definition; but after its inception, the approach was carefully studied and codified, thus transforming the method into codified knowledge or "raw material". The same happens for many industrial accomplishments. Thus, to gain commercial advantages it is essential to have the exclusive availability of excellent raw material and to favour, using tacit knowledge, the rapid assembly of basic components.

The above aspects accompany an important evolution with respect to the past. Just a few decades ago we had distinct phases, separated in time: the generation of tacit intellect, its pre-coding exhibited at technical meetings and published in scientific literature, the disclosure of pre-codified knowledge to possible end-users, the transformation into codified knowledge, and its application to industrial products. The actors of the various phases were well identified: we had scientists and educators at the beginning and industrial executives at the end of the process. What happens now is that all the phases have collapsed one into each other running the great risk of mixing-up roles and purposes.

Different Viewpoints

The major sources of mismatch between university and industry come from different viewpoints. For university the main purpose is to "seek truth"; for industry the key issue is "business". The arguments from both parties are convincing. University professors and researchers think that their role is to freely investigate without real constrains: research is merely driven by the cultural curiosity of researchers. Many of these adhere to a reflection by A. Graham Bell that states: "Leave the beaten track occasionally and dive into the wood. You will be certain to find something that you have never seen before." This basic concept is widely followed; the exploitation of findings does not preoccupy researchers: they often think: "If somebody is capable of appreciating the value of my discoveries, then he deserves to enjoy the ensuing economic benefits". In many situations scientists maintain a rigorous cultural independence, researchers spend days or weeks in finding a solution to a particular problem and in making the explanation formally rigorous and as general as possible; they are sceptical of the real importance of any link to practical (or "trivial") problems. For them competition lies in the priority of discoveries and inventions. Moreover, for scientists, money is not important by itself; possibly it is just a measure of achievement. Thus, to summarise, scientists are fundamentally "fuzzy" [2].

In contrast, industry executives regard time-to-market (or, as they say nowadays, time-to-profit) as the fundamental guideline: if a product is six months late it loses 40% of the potential market. Speed in any industrial operation is extremely important: executives don't allow time for esoteric speculations, each step of the production ladder must be well defined, controlled and possibly codified. These must be quick steps, and have the accompanying targets of improving quality and pursuing higher customer satisfaction. The main aim is to have new products on the market well in advance with respect to competitors (and to make a profit). The important thing is, pragmatically, getting results and not understanding causes. Moreover, it is essential to place a heavy emphasis on the patient, downstream technical work needed to turn brilliant ideas into products that people will buy. The art of manufacturing is the key to success [3]. In addition, money is the propelling force. Without money executives simply die. Therefore, to sum up, industry executives are fundamentally “crisp”.

Another important difference concerns training: it is the essential role of universities. Universities exist and societies support them for two reasons: to generate and preserve culture and knowledge, and to transfer this culture and knowledge to younger generations. The universities create (or pretend to crete) the fundamentals in building “modern societies”, they determine (or pretend to determine) the underlying conditions for the proper future ruling class. In universities training points to cultural and scientific enrichment.

For industry the training is a more solid and well defined concept: making workers perfectly skilled in the use of tools, machines and procedures for a more efficient and quick transformation of raw material into products. The demand from industry, especially high-tech ones, are sometimes controversial: they like to receive people with a solid background but then they complain because of their lack of ability in using tools and knowledge of specific procedures. Actually, the cost of training employees in the use of tools and getting them used to internal procedures is high and, in particular, takes time. Therefore, tuition should have very explicit targets as industrial training is focused by productive needs.

Finally, the real point of conflict: disclosure of knowledge; the reward system of science is based on the priority of development. The individual’s reputation mainly depends on the accumulation of pertinent prior discoveries. Thus, the community of academic scientists spends much effort in tracking who achieved a given development and when. The scientific activity is a race with some secrecy along the way but when the results are reached they are fully disclosed to the scientific community, that calls for the proof of replication. The accuracy and completeness of disclosure is always considered an important element of merit. Moreover, the educational role of university imposes a free delivery of knowledge. Nowadays advanced knowledge is a perishable good, universities and scientists are fully recognised only when they deliver “fresh goods”.

Instead, for industries disclosing information is a perilous avenue. Technological supremacy and, consequently a commercial advantage, mainly comes from coded knowledge (the new raw material) that must be kept confidential and protected against attack by competitors. The instruments for normal protection are patents; they are filed copiously (and expensively) to create a thicket of legal defence. But when patents are not sufficient, secrecy becomes the fundamental practice. Knowledge is partially disclosed only for trading purposes: to show a company’s strength to competitors and to demonstrate technological effectiveness to customers. The defence and the protection of knowledge seems vital in very advanced products. An high level of defence persists until the “good has perished”. As a possible defensive strategy, occasionally knowledge is kept at a tacit level making its transfer more difficult and, therefore, better protected. Although this technique conflicts with production optimization and industrial training necessities, it is considered the “minor evil”. The above attitudes are fully justified: when competitors steal knowledge (at zero cost) they acquire an advantage that can be fundamental in the commercial antagonistic arena.

Wrong approaches

The different viewpoints leads to two possible effects: isolation or predominance, which produce four possible wrong approaches: university staying in the ivory tower, monad industry, slave university and vassal industry. We shall analyse these before discussing other elements capable of leading us in the right direction toward matching the apparently conflicting aims of universities and industries.

- *University staying in the ivory tower*: this approach is the classical one. For centuries universities have been a caste with a weak link to the “real world”. As already mentioned, this was due to the separation of cultural speculation, study, experiments and discoveries from the practical transformation into solid benefits. Society accepted paying for the cost of the “ivory tower” because of the glowing and the mysterious authoritativeness resulting from the magical control of knowledge. Starting from the Middle Age, an illuminated ruling class founded and protected higher educational institutions in

Europe and later in the USA, thus triggering a slow process that centuries later sprang into the industrial revolution and was followed by the information society. The inhabitants of the ivory tower were respected and untouched. Admission to the caste was by invitation, thus circumventing any feedback control. The only authentication needed for the inhabitants of the tower was a self-introspection and a self-defined ethic. The risk associated with this approach for today's situations is evident: an increasing divergency of needs and activities, with the peril that universities achievements become "good for nothing". The fundamental sin behind this approach is cultural arrogance.

- *Monad Industry* (monad, in philosophy, is an autonomous vital entity): this case resulted probably as a reaction to the weak link of the "ivory tower" to real and practical problems. Industry identified gaps in the advanced production map and decided to fill them autonomously. Gaps appeared for a number of reasons, such as new scientific needs, an intensified push from technology, increasing dynamism in the productive world, theft of knowledge by competitors. Industries changed their role from detectors of research values and their proper exploitation, to generators of focused knowledge, pointing directly at their own specific needs. Certainly the monad industry approach is beneficial (in the short range) for the industries themselves. One of the major concerns is knowledge protection (or, from a different viewpoint, the defence of "brain-produced raw materials"). Thus, the self-generation of know-how and its non-disclosure becomes an effective answer. Important industries appoint powerful and well endowed research centres for the production of commissioned and proprietary science, thus, receiving significant benefits. Nevertheless, the limited interactions due to secrecy inevitably produce the same weaknesses as the "ivory tower" phenomenon. The targets of "proprietary science" become disconnected with the social world and sooner or later monad industries strive to impose artificial needs on customers and promote unattractive products on the market. This determines, after an initially beneficial period, an implosion and the quick decline of the monad. The fundamental sin behind the monad industry approach is the cultural disaffection.
- *Slave University*: A common (but erroneous) consequence of the monad industry is the attempt to establish a sort of jurisdiction over the university. One key need of industry is to receive a constant flow of properly educated brains. However, this rigid industrial closure impoverishes higher educational centres making the internal training of the newly acquired work force more expensive and less efficient. This drawback, in addition to the need for some extramural cultural feedback, leads to various forms of obligatory support (economical or technological) to universities in the hope that training cost will be attenuated and cultural isolation reduced. Sadly to say, even public funding bodies tend to push universities into the slave direction. Holding universities tight to solid objectives eludes the difficult task of a cultural and strategic coordination of efforts. Hence, culturally weak bureaucrats and politicians can better defend themselves from criticism by unhappy tax payers. The negativeness of the slave university policy becomes evident on the long range when (hopefully for them) unsuitable administrators are already retired. The fundamental sin behind this approach is cultural meanness.
- *Vassal Industry*: this model repeatedly results from the contact of small enterprises with universities. The amount of knowledge (and its "freshness") necessary for producing high-tech products is enormous and, unless the company is a spin-off emanated from a big industry or a good university, a small productive reality doesn't have the strength (cultural or economical) to improve its internal technical asset. In an attempt to redress this problem contact with the university is forged from a subordinate position that often produces a dependent relationship. The cultural mismatch: a very cerebral and analytical researcher on the one hand and a pragmatic craftsman on the other, is responsible for this effect. Even if not very common, we can also have the vassal industry phenomenon with big industries. This happens in the case of famous universities leading some disciplines; in these circumstances the universities keep a significant part of the knowledge that they generate at the tacit level and use this undisclosed knowledge as a powerful negotiating tool in industrial liaisons. The fundamental sin behind this approach is the cultural presumptuously.

Motivation in Innovators

Many psychologists have stressed the importance of motivation. Their conclusions have an important impact on the generation of knowledge and its transformation into well-being. The psychologist Abraham Maslow developed an analysis grid that distinguishes needs in five categories: physiological, safety, social/affiliation, esteem/recognition and self-actualization. Since the key actors in the knowledge society are the innovators (either belonging to the "realm of technology" or the "republic of science"), the safekeeping of innovator' motivation is a very important political and managerial issue. An innovator has a natural inner push for "building knowledge", but the effectiveness of the required brain process strongly depends on the enforcing stress coming from the motivation. For innovators the last two steps of Maslow's ladder are important. The esteem/recognition has a direct impact on a proper liaison between university and industry. By contrast, the self-actualisation has a minor short range impact since it stems from personal realization. Nevertheless, both are essential: therefore, it is necessary to understand which conditions favour or depress the search for satisfaction. Incidentally, we have to observe that the right driving force is not "being gratified" but to continue "pursuing satisfaction".

Many years ago I asked myself what are the five motivating forces for human beings. I was joking with myself, but after a while I wrote on a piece of paper five apparently unconnected answer: power, money, glory, love, and stupidity. I pinned that piece of paper on the board of my office and that message was facing me for some time reminding me that, most likely, answer #5 was the most applicable. If we ponder the result of that joke we realise that it is not complete nonsense. Actually, the 5 responses guide innovator' motivation. The first two answers mainly refer to the "the realm of technology" the remaining three to the "republic of science":

- The quest for *power* is an old story, we have plenty of examples, most of them lead to sad conclusions. Even if pursuing power is initially motivated by some spirit of service, after a while it turns into negative intents with serious impediments to progress. For this reason, it is essential that the "feedback" of the system reacts promptly to any accumulation of power. Typically, power, a certain strong element, rarely leads to the satisfaction of the esteem/recognition or self-actualization needs.
- *Money* is a real motivator? Money is not everything, they say; that's true, especially when you have plenty of money. But also, money is not only what is needed to buy the necessities of life. It represents more, notably for innovators; first, money must corresponds to the presumed social value of the innovator's contribution. Second, in many cases, money in itself is not the source of motivation but, perhaps, it is the measure of achievement. Thus, a proper salary policy is an excellent innovation catalyst: of course, money must satisfy safety needs but beyond that level money becomes a measure and not a necessity: the relative amount becomes the important issue.
- *Glory*: who doesn't desire to hand down something to posterity? This is why researchers compete for priority in discoveries. This is why scientists don't take manufacturing issues very seriously. For them what is essential is simply to invent and to become famous. Thus, the pursuit of glory surely satisfy the esteem/recognition or self-actualization needs. Nevertheless, it represents a problematic attitude for a proper balance of the industry-university relationship.
- *Love*: this emotion is, in some ways, much stronger than money. Innovators that love an idea, a process, a technology promote them strongly, with robust determination. However, as in normal life, love is blind. When somebody loves something he/she doesn't see the real limits and the flaws that often make the beloved issue unsuitable. Thus, again, love satisfies the esteem/recognition and self-actualization needs but it is a problematic feeling when balancing the industry-university liaison.
- *Stupidity*: everybody, at least once in life, has seriously declared about themselves: "I am a stupid guy". The reason is that often we don't see a logical reason behind our commitments. Nonsense! In reality, we don't discern in the environment where we operate any possible source of gratification to our esteem/recognition needs. We are angry with the organization we work for because it doesn't perceive and account for our merit. Nevertheless, we continue in our persevering undertaking and, at the same time, we think: "It is not worthwhile". Therefore, stupidity is a strong motivator behind innovation, while corresponding to esteem/recognition needs negatively: it really is a highly non-linear answer to inadequacies.

The above analysis provides some elements towards making the innovation process more efficient: the motivation of innovators is essential. Consequently we need, among other elements, an appropriate social environment, feedback, technological and operative tools, an appropriate use of money.

The Role of Managers

The search for the university industry balance requires an additional element: the right behaviour by managers. It is generally lamented that managers do not take the long term view. They normally sacrifice the long for the short and this can become a substantial obstacle in our search of a proper university industry balance. The short range attitude strongly depends on the constant risk of hostile takeovers and by the inexistent long-term loyalty of the stock market. Fortunately, these conditions are beginning to change nowadays, nonetheless, they still influence managerial attitudes. Pat Pitcher [4] identified three different managerial types: they are: the technocrat, the craftsman, and the artist.

- *Technocrat* uses sophisticated managerial techniques, he is conservative, methodical and controlled; he studies analytically and meticulously any possible decision; he is serious and in some cases distant.
- The *craftsman* inspires trust in people that perceive as genuine the sacrifices they are called upon to make; craft believes that experience and practice are essential: learn by example is his favoured practice; he is straightforward, reasonable and open-minded; socially he is amiable.
- Audacious with decisions and disdainful on details and how to proceed characterise the *artist*; he is intuitive, exciting and able to galvanize people; his strategy is just an image and not a plan: go ahead, become big; the artist fast makes both good friends or strong enemies.

These three archetypes of managers have different consequences on the most critical issue: the disclosure of information. If we have an artist or a craftsman running the company board, there is ready access to information, healthy debate, diligence, dedication, and serious involvement. Where there is a technocrat in charge there is little of the above. Actually, the real point is not the single manager but the composition of managerial teams; how many artists, craftsman, and technocrats run the company, and the relationship and the balance among them. Pitcher gives us a recipe that seems optimal: at the top we need an artist to provide the vision and the inspiration. Then, we have the board committees: the audit committee should be steered by a technocrat; the human resources by a craftsman; the nomination committee by an artist but including the other two types. Under the board it is essential to have a craftsman and, in the staff strong technocrats. Thus, the proper solution is to have an harmonious blending of the three archetypes.

The role of public money

A final element deserving attention is the role of public money. Its use in promoting research and development is a very controversial issue: opinions range from a fully positive assessment to a sharp: “legalised theft” [3]. Universities are, to a large extent, public institutions; therefore, in addition to support for their educational role they receive public funds for the generation of basic knowledge, and this is generally accepted. Nevertheless, more and more universities receive external resources from national or international funding bodies and money directly from industries. Conversely, industries began to receive public resources for fundamental and industrial research. In addition, industries receive (and have received) indirect support because of “privileged” purchase orders from public institutions, mainly for military purposes.

Public assistance to industries doesn’t extend (or should not extend) the pre-competitive development level, because the small distance from the market would “distort competition by favouring certain undertakings on the production of certain goods” (from the Art. 92 of the Treaty of the European Union). Therefore, the assistance which is legally admissible is for fundamental research, that means *activity designed to broaden scientific and technical knowledge not linked to industrial or commercial objectives*, and for industrial research, that means *planned research of critical investigations aimed at the acquisition of new knowledge, the objective being that such knowledge may be useful in developing new products, processes or services or in bringing about a significant improvement in existing products, processes or services*.

Apart for the limits of the law it is important to analyse benefits and disadvantages of public help to applied research. The cost of modern technologies is particularly high and receiving some financial relief is particularly welcomed. Nevertheless, the received money is, in some sense, equivalent to using a net under an acrobat flying between trapezes in the circus. The net is an essential guarantee for the acrobat’s safety but, it also limits the value of the performance and establishes a mind-set for the acrobat himself. The net, in fact, significantly reduces the acrobat’s savouring of risk (entrepreneurial taste), reduces motivation and lowers the level of the acrobat’s attention; thus, the quality of performances is depressed and surely below its possible maximum. Moreover, the net allows mediocre acrobats to hang from the trapeze and produce displeasing exhibitions. Therefore, the net is, at the same time a protection of and a burden on achievements. Another negative effect is that the net quickly becomes a right: no net, no performance (no public money, no research: the drug effect); thus, the cost changes into a pure overhead. Finally the management efficiency of public money, because of the need for transparency, its bureaucratic costs, the rigidity of the system, and the inadequacy of actors, is quite low (I have estimated below 50%). To conclude, public money seems to produce modest impacts on a direct generation of well-being. Instead, as we will see shortly, it could produce some benefits in favouring proper “boundary conditions”.

The right (?) model

The elements discussed above assist us in the search for a proper association between universities and industries. A huge help in this undertaking came from H. Bahrami and S. Evans that have lucidly and profoundly studied various facets of high-technology entrepreneurship [5]: their paper provides a solid frame that will guide this section. Specifically, Bahrami and Evans study the conglomeration of firms established in the Silicon Valley and discuss the mechanism that was able to activate such an energetic technical and economical progress. The Silicon Valley effect, albeit geographically localised and centred around a specific technical subject, is vast enough to be applied to our purpose.

A basic concept that immediately helps is the “ecosystem”: Bahrami and Evans view the entire Silicon Valley like an ecological system in which different components conform to rules similar to the ones in a natural environment. The basic elements of the Silicon Valley ecosystem are: firm, university, support infrastructure, venture capital, talent pool, entrepreneurial spirit, lead users. Some constituents are solid, other abstract; nevertheless, we have to consider them as an harmonious aggregate. The rules and the operating conditions blending the basic ingredients are: re-cycling, flexibility, ethic behaviour, cooperative spirit, inter-firm mobility, rapid transmission and wide spread of information, doing rather just knowing, learning by doing and failing, speed of manoeuvre.

It is not necessary to enter into a detailed analysis to catch the substantial difference between the Silicon Valley model and other realities familiar to us. One point that attracts our attention concerns secrecy, the normal practice used in industry: it seems deleterious for the ecosystem. Monads existing only in books of philosophy but not in nature: what makes systems vital is the communication network with a rich exchange of data. Actually, the release of technical information is necessary to ensure the compatibility of the various technical subsystems so that related products can interface effectively. Moreover, the rapid pace of change quickly makes information on advanced solutions and the market obsolete. Another important rule is “learning by doing and failing”. The leading edge activities (the ones potentially more profitable) derive from tacit knowledge and not from “brain-produced raw materials”; and tacit knowledge is generated and transferred by “doing” but also by “failing”. This issue is very important for the educational role: students must have the chance to make mistakes, especially on advanced topics. This will enhance their creativity: a positive attitude toward failure is essential for the success of pioneering high-tech initiatives.

A crucial element of the ecosystem is venture capital: it provides, with private money, the financial resources to start and grow new entities. Actually, venture capital brings into the equation other important elements like management know-how, and a network of contact to enforce the teams. Moreover, other basic services, like the provision of high-tech facilities, marketing studies and so on, are furnished by specialised private entities. We should outline the absence of the public hand in the productive circuit, and this is positive. The use of tax-payers money requires prudent handling, with severe rules, bureaucracy, audits, and other strings slowing the process. Thus, when the money comes it is often no longer necessary or it is called (and used) for other needs. Instead, public money must provide proper “boundary conditions”; in addition to the university (that should be only partially supported) it is necessary to have a favourable socio-economical atmosphere, to enhance and sustain culture in all its aspects, to protect the environment, to offer a high level of social services. In any case, direct money to industry should be avoided, it would be like granting frozen fish to assist a fishing boat, or giving pocket money to a 35 years old boy to encourage him to become adult.

The appropriate model for regulating the today university-industry relationship considers university and industry as two components of an ecosystem. The basic guideline is symbiosis: what is practised by animals or trees in living together with reciprocal benefits. Certainly the functions are different but the main objective must be the same: safeguard of the ecosystem. Some actions can be beneficial in the short range for one or other party but an impoverishment, even a slow or imperceptible one, is the source of long range problems. This is generally true but, unlike the past, the rapid pace of evolution continuously reduces the correction margins.

The concept of ecosystem recall two perceptions: complementarity and harmony. Thus, university and industry must have complementary roles: generation of knowledge and its exploitation. They must harmonise with the other components of the ecosystem remembering that the main beneficiary of efforts is the system itself; the advantage for a single component results from the smooth operation of the entire system; the boundary between various roles must be flexible with strong links and a partial, temporary integration of functions.

This possible model works properly in a growing system; and, this is actually what a university should foster. When the system tends to a stable condition the growth rate decreases and the ecosystem inclines toward the mature phase, quickly followed by decline. This natural consequence is moderated by the re-cycling and inter-firm/university mobility. Entities that become old and no longer able to keep the system pace should terminate and re-cycled into new realities. There is another additional problem: when firms and universities become too big they potentially create imbalances, just as elephants do in the savanna. Big entities are latent monopolies. They drain all the available resources biasing technical and social activities, thus distorting the rules of a healthy ecosystem. The most suitable solution to the resulting ecosystem impoverishment is a form of tight self-control for big realities.

Conclusions

As anticipated in the introduction, the elements discussed in this paper don't constitute an organic whole capable of proposing solid recommendations. Actually, the university-industry relationship will not find its balance just by applying “crisp” rules but much more so by favouring “fuzzy” attitudes. The “crisp” rules (or, better, well-defined problems calling for a solution) mean devising different mechanisms for protecting proprietary knowledge, actions for replacing ivory towers with “science gardens” (and kindergartens), instruments for sustaining motivation, proper and more efficient use of public money, suitable re-training and cultural enhancement of bureaucrats and politicians.

The discussed model is more of a concept than a recipe, the implementation of the concept depends on the specific habitat where it should be applied. It will be driven by the relevant culture and habits. It will require a “custom regional” accomplishment. Nevertheless, we have two common rules: moving to an ecosystem viewpoint, and enhancing openness. We always have to remember that the brain is made of simple processing elements (the neurons). What makes it unrivalled is the huge synaptic connective network.

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