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The crucial human factor in innovation

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THE CRUCIAL HUMAN FACTOR IN INNOVATION

Georges Haour

Drawing from learnings gained from practice, as well as from studying the process of innovation, the author concludes that, by far, the success of an innovation project is essentially a function of the talent and motivation of the persons involved. Therefore, management may bring considerable value by taking the time to ensure these two critical requirements. In comparison with this priority, firms should place little importance on "frameworks" and consultants' "models"; instead, managers should trust their collective strength, rather than escaping into hiring external "help".

After looking at the act of creation, the fire of innovative activity, this chapter concentrates on technology-intensive innovations. The latter provides a powerful tool for changing the world and creating wealth. As they represent the key force in this dynamic, technical knowledge workers constitute our focus: their profile and what they require in order to thrive. Attention will then be given to what these requirements mean for management. Lastly, the importance of the human factor will be illustrated with the specific aspect of innovation, which involves the complex transition of "academic" research to commercially successful ventures, following the path called "technology transfer".

Introduction: creation and the essence of innovation

After looking at the act of creation, we'll briefly look at past literature concerned with the human factor in innovation. The dominating drivers for change and innovation in the coming years will then be explored. Finally, the objective of the chapter will be presented.

The mysterious act of creation

The arts and science constitute central elements of the human genius. Ultimate masterpieces, such as Plato's *Republic*, Monteverdi' *Orfeo*, amazing works of art from the Ming dynasty, Leonardo da Vinci's *La Joconde*, Bach's Saint John Passion, Hokusai's wondrous Uki-yoe, Monet's impressionist paintings, Stravinsky's "Rite of Spring", Fleming's discovery of penicillin, because of "his prepared mind" and Berg's *Wozzeck* are a few examples. These superb works are the products of the genius, passion and commitment of individuals. They are most appropriate to depict

the great myths of humanity. Carl Jung calls on works of art to illustrate the icons of mankind's mental universe (1968).

In order to evoke the mysteries of the creation process, philosophers have sometimes described creative geniuses as sleepwalkers. Among them, Arthur Koestler (2012) shows how Kepler made two mistakes cancelling each other so that, guided by a mysterious inspiration, he arrived at the proper equation for the elliptic path of the earth. A perspective on scientific discovery is provided by Thomas Kuhn (1962). According to his famed concept of "paradigm shift", a scientific theory goes on as "normal science" until it is progressively challenged to a point of crisis, at which point a new theory takes over. Two theories shift like tectonic plates until they collide, causing an earthquake.

The creative genius of individuals is at the heart of the discovery process, whether in the arts, spice in our lives or in the sciences. It constitutes the essence of the innovation process. By this phrase, we mean going from a novel idea to commercial success. In an attempt to improve their competitive position, firms orchestrate this difficult and unpredictable journey in order to develop differentiated offerings and to make their operations more efficient.

Drivers of change

Because of the digital revolution, the world is undergoing unprecedented, massive change. All sectors of activity are affected by the "digital tsunami". The latter includes 5G, first used on a large scale by Korean Telecom at the 2018 Winter Olympics, allowing a capacity to transmit data roughly 100 times that of 4G. This "digital revolution" includes the Internet of Things (IoT). It is anticipated that 50 billion objects will be connected by 2020, offering an environment that, no doubt, will be exploited by the "hackers". Also coming into play are robotics, big data and analytics, artificial intelligence (AI) and the much-talked-about blockchain.

A special event at the International Institute for Management Development (IMD) in Switzerland, on October 4 and 5, 2018, deals with this panoply of techniques as they affect every sector, turning business models upside down and displacing jobs. The Internet allows cutting out the "middle person", putting consumers in direct contact with suppliers of services. This also makes it possible to accumulate enormous amount of data, which may be valuable to certain organisations. The slogan is: "data is the commodity of the 21st century".

Expected to be particularly affected are the healthcare sector, partly because it has been so slow to move in this area, manufacturing, entertainment and gaming, "fintech" and driverless means of transportation, automobiles in particular. China, the ultimate Internet country, is accelerating its efforts on many fronts with breakneck speed. Shanghai is already the world's capital for "fintech".

On occasion, our societies feel brutalised by the digital revolution. Concerns about cybersecurity are in order. Substantial economic losses are evoked, with estimated figures around $2 trillion worldwide in 2020 as a result of hacking. The annual Def Con cybersecurity conference is always very well attended. This, mitigating risks is in order. Ethical issues should be debated much more. It can be said that algorithms themselves are not "neutral", as they assume a certain set of values.

In dealing with this wild horse, there is sporadic resistance: some people prefer queuing at human cashiers, rather than dealing with charmless machines. For others, "the more digital the world becomes, the more handwritten notes I send". The "lights and shadows" of the digital brave new world should be lucidly evaluated and debated.

Citizens' control of their private data is a central concern. Europe is the first region in the world to take regulatory action in this area – the General Data Protection Regulation (GDPR)

– in full force late May 2018. Indeed, our toxic world demands "smart regulation", in order to protect citizens without stifling economic dynamism.

The digital, geopolitical and ecological changes are prompting consultants and business school types to utter a lot of "gobbledygook" on the managerial attributes required to face these challenges. Words such as "agility, leadership, ecosystems" and "open innovation and cloud sourcing" are uttered *ad nauseam*, but are inadequate to help navigate the resulting rumbustious business environment. The discourse remains at the general macro level and does not articulate any useful wisdom to individuals.

Brief review

Considering how important the motivation and the talent of individuals involved in innovations are, few authors look at the value system and the factors creating strong morale in these individuals. What specific practices and managerial approaches allow and stimulate such individuals to thrive and be productive? Similar considerations apply to public laboratories, nonprofit institutions and university research departments.

Entrepreneurship, or, rather, the entrepreneurial spirit, is necessary, but not sufficient, for innovation to be successful. Its proactive energy constitutes the booster, which catapults innovative offerings into market. In this area, there is much hype about the so-called "entrepreneurial universities".[1]. Many years ago, the private University Babson, in Boston, made entrepreneurship central to its brand. Several Chinese universities are blowing the same trumpet. How does one *effectively* teach entrepreneurship? In the UK, the "Cambridge phenomenon" took place well before anybody was concerned with this question. It happened because there were a few compelling role models, as well as through good practice, such as that at the St John's Innovation Centre, founded in 1987. Its first director, Walter Herriot, well understood the needs of entrepreneurs.

Rather than giving many references to articles, let us highlight a 2012 OECD report reviewing this area.[2] This report lists the components of an "entrepreneurial university". These are: (1) leadership and governance; (2) organisational capacity, people and incentives; (3) entrepreneurship development in teaching and learning; (4) pathways for entrepreneurs; (5) relationships with business; (6) entrepreneurial university as an internationalised institution; and (7) measuring the impact of the entrepreneurial university.

Typically, papers on the human factor and innovation concentrate on the "framework conditions" promoting innovativeness. These are very "macro" considerations, including typologies for the staff. Human resources are taken as an aggregate entity. No consideration is taken as to how to ensure in talented *individuals* the motivation and energy required to make innovation succeed (Christina, 2012; Livesay, 1996). This is also the perspective of the 2014 edition of the annual Global Innovation Index (GII) from the World Intellectual Property Organization (WIPO), a ranking that has put Switzerland on the top place for the last six years. In 2014, the GII focussed on the theme "The Human Factor".[3] By that was meant statistics on the number of graduates, professionals and science parks. These macro-issues do not tell anything about what motivates *individuals*.

Objective of the chapter

In the universe of creativity, innovation and massive change described earlier, this chapter looks at the human factor in the innovation process. We focus on individuals working in companies, including large corporations, small and medium enterprises (SMEs), and start-ups.

Many innovations are non-technical in nature. The example of self-service shows that a major new approach may revolutionise a sector, retail in this case, without involving any technology. On a different level, the European Union constitutes one of the most remarkable innovations (and often a frustrating one) in human history. Our world needs effective conceptual innovations in order to deal with the rapid and massive changes affecting it. In the absence of leadership, these are slow in coming, as the inertia in the system is astounding, likely only to be shaken by the compelling pressure from citizens. There are, however, signs of change. For the first time, the Queen of England has taken a public stand on an environmental issue: "I declare war on plastic", she said on February 12, 2018.[4]

Technical change, particularly in the digital sphere, will continue to be key in solving world's problems and to create wealth for people. This chapter focusses on the human factor in technology-intensive innovations, because they represent the lion's share of the wealth-creation process. We first discuss the characteristics of the key actors in technical innovations (e.g. technical knowledge workers). We will then look at the implications of these characteristics for management. Lastly, we will look at the complex process of technology knowledge transfer.

The technical knowledge worker

Technical knowledge workers are somewhat different from other knowledge workers. Managers of a department for technical development, such as R&D must be sensitive to these differences, discussed next.

Technical content versus process

A student working on the research towards obtaining a PhD in science is likely to consider the world of management very pejoratively: what is paramount to such a student is the *content* of the scientific work and the challenge of progressing knowledge in a very specialised field. Indeed, scientists consider their expertise in a scientific discipline a central part of their identity. With it, scientists characterise themselves: they say "I am a physicist", or "I am a biologist", just like somebody would say: " I am a medical doctor" or "I am a lawyer".

In contrast with the importance of technical *content*, people involved in *processes*, such as managers and consultants, are often considered peripheral. Collective memory confirms the supremacy of content over process. One example is the WWII Manhattan Project, which was set up with a staff of 130,000 persons to develop the nuclear bombs that were dropped on Hiroshima and Nagasaki in August 6 and 9, 1945.[5] History does not recall the name of the project manager, but only the names of the physicists, particularly Robert Oppenheimer, head of the Los Alamos Laboratory, as well as Leo Szilard and Albert Einstein. This recognises the fundamental fact that without expert technical knowledge, there is no project, whereas project management is sort of a commodity.

Our contemporary times sometimes seem to forget this basic fact. Excessive emphasis is often put on the marketing, the financing and managerial practices. Considerable hype surrounds startups, these budding firms that often have a technical innovation at their origin. In Silicon Valley, the proximity of Hollywood seems to encourage the "spin doctors" to hyperbolic exaggeration, when, in fact, the success rate is no better than anywhere in the world: roughly, 75 percent of technical startups die within five years. China seems to be on the same bandwagon, with occasional extravagant story telling on start-ups, incubators, etc. It is nice to see Switzerland remaining true to the quality of content, using a low-key approach and soberness!

Who are the founders of start-ups? Engineers, of course. They bring the technical content, which constitutes the basis for the new business, but they need additional skills to develop it. These skills are often provided by a colleague with a different orientation. Most start-ups have two founders who trust each other: one engineer contributes the technical content, the other one, more extroverted, deals with marketing and business. Technical experts develop management skills and business sense over time, following the path given in the graph in Figure 20.1. A primary responsibility of managers is to help individual staff members develop. Occasionally, timely executive education programmes make it possible to accelerate and amplify this evolution. Thus, management development may truly be an agent of change.

Need for autonomy

Another characteristic of knowledge workers is their high need for autonomy. Since expertise is so important to them, it defines much of their value system and behaviour. They feel that they know best and resent advice or managerial interference. They are difficult to manage in the sense that, in order to be "accepted", a manager must be legitimate in terms of background and track record. In certain cases, technical experts elect to remain technical contributors, growing in seniority without managing any staff. The technical path, parallel to the managerial cursus, constitutes the "dual ladder" system.

Knowledge workers, such as medical doctors, journalists and lawyers, represent a challenge for managers similar to that of technical knowledge workers. It is often said that such staff are fiercely individualistic, just like cats. As is well known, there is no such thing as "corralling a herd of cats".

The expert syndrome

The pride of knowledge workers in their technical competency may be illustrated by a survey of researchers of the contract research organisation Battelle. They were asked: "Why are

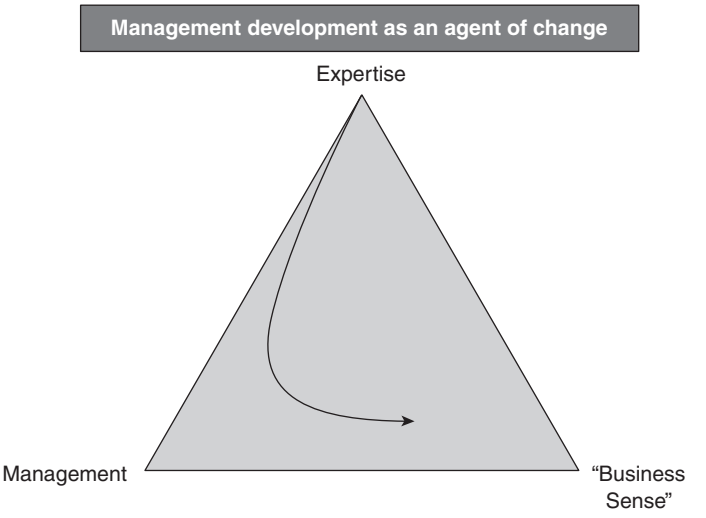

Figure 20.1 Management development as an agent of change

clients funding innovation projects with you as project manager?" More than 80 percent of their answers were "because of my recognized expertise", while the clients' reply was "because we have an issue to resolve".

As a result of their pride, as well as their need for independence, knowledge workers are unlikely to readily engage in collaborations and exchanges with colleagues. Why should they, since they are so good themselves? Furthermore, engaging in a collaboration may expose areas of ignorance, a direct threat to their "prima donna" status. Here again, management must tactfully convince individual experts to engage and collaborate.

In an attempt to seduce experts, start-ups offer a "fun" office space, with colourful coaches, dart games, etc. Instead of such gimmicks, it seems preferable to offer an excellent cafeteria, an efficient nursery for the employees' children, astute advice for personal finances, generous sabbaticals or attractive rotations in other parts of the firm. In-kind advantages provided by certain Chinese firms, such as company cars or low-interest loans for purchasing real estate, are also effective in attracting and retaining staff.

Knowledge inertia

A firm that has outstanding experts in a given discipline, say metallurgical engineering, will want to keep them busy with challenging projects in their specific field. This constraining legacy compels management to continue ploughing the same furrow in comfortable complacency. In fact, these investments should be directed towards more future-oriented projects.

Companies find it difficult to interrupt projects. This is due to a lack of courage and the fear of demotivating the teams. This is an ill-placed concern. The key is to kill projects, not the project members! The reasons, business or otherwise, for stopping a project must be explained to the project team. If done properly, that is, if the management *takes the time* to explain why an activity must be stopped, such interruptions provide an opportunity for a powerful pedagogical message. In most cases, management does not seize this opportunity.

For a company, such inertia often leads to disasters. Examples include Kodak, which failed to manage the advent of digital photography. At the level of an entire industry, in the early 1970s, the senior management of the Swiss watch sector rejected the quartz watch, because it could not resolve itself to abandon the considerable and unique know-how of their staff in precisely making mechanical watches. The Japanese firms then took over the market. The Swiss sector only recovered when the "Swatch" was launched in the late 1980s by combining innovations in design, provided by engineers Mock and Mueller, and advanced manufacturing and marketing,[6] under the leadership of Dr. Ernst Thomke.

Knowledge workers need organisational stability

Uncertainty is at the core of technical research. Indeed, if the results of a project were known, there would no need to carry it out. The daily work of the researcher is a constant battle, more or less acute, depending on the time, against an unclear outcome. With uncertainty central to their work, researchers feel the need to have a stable environment. Management must strive at providing this, in particular, by supporting the researcher and showing empathy when the project goes through difficult phases. This must be done in a positive manner, making relevant suggestions on how to proceed or on what colleagues to contact for help.

Mergers and acquisitions (M&A) represent periods of major uncertainty. These must be as short as possible. The vision of the newly formed entity must be diligently formulated and its organisational structure clarified promptly. Duplications are eliminated, with R&D departments

often at the top of the list of activities to be "streamlined" in order to reduce costs. Researchers are unsettled by such uncertainty, so that, during this period, the innovativeness and the research productivity go way down. It is therefore very important to point to the future so that the innovative heart of the firm can start beating again. When Roche acquired the diagnostics company Boehringer Manheim, it decided to manage the merger fully internally, which was the proper thing to do. As a result, the merging process was carried out, retaining the trust from the staff and with due speed, so that the innovation spirit of the development teams was altered relatively little.[7] Roche, admittedly the best pharmaceutical firm in the world, has a history of intelligently handling relationships with new partners, such as Genentech or Chugai.

The richness of diversity in teams

By and large, more diverse teams, or a more multicultural staff, are less conformist and more creative.[8] There is a caveat, however: the desired outcome is obtained *only* if managers see a multicultural staff as a positive asset. Managers who are not at ease with this or do not know how to effectively deal with diversity actually destroy this potential.

Why is diversity an advantage for innovation? People from different genders, social origins, countries, cultures, etc., engage more in debate and dialogue. Robust conversations develop, from which new ideas are more likely to emerge. Coming with different sets of contacts, they have antennas into diverse worlds. In this area, Europe's unique richness of diversity represents a considerable asset. For example, teams involved in projects from the European Union's "framework projects" are the most diverse in the world. Such projects gather people from small and large firms, public and private, from universities and private laboratories, coming from different countries. Managing such teams demands persons who are able to turn this complexity into an asset. When the sophistication of effectively managing highly diverse teams is lacking, however, this complexity is only cumbersome. In most cases, problems encountered in projects are managerial in nature, not technical. Although not a member of the EU, Switzerland fully participates in the EU programmes. This constitutes a testimony to the importance of being part of the European research area. It is probably also because such a multicultural country fully understands the power of diversity.

There are exceptions to the rule: effective innovativeness and market orientation do not absolutely require staff diversity. For example, in Japan in the 1980s, homogeneously Japanese staff belonging to very Japanese companies such as Canon, Sharp or Toyota developed new, winning offerings, which conquered the world. Japan, with a monoculture population and limited global outlook (on boards of Japanese firms, fewer than 1 percent of their members are not Japanese), continues to be a powerhouse for (technical) innovation.

Researchers-entrepreneurs

As a manager of a unit at Battelle in Geneva, the author of this chapter hired a number of researchers from various countries in order to build the diversity mentioned earlier. One phrase used to describe the job was "I need researchers-entrepreneurs". These two words are not usually put together. In fact, common wisdom considers that these two profiles are not found in the same person. This is supported by the fact that, as mentioned earlier, engineers starting new technical ventures find a colleague as an associate, who brings an orientation towards business and entrepreneurship.

Our societies do not want everybody to be an entrepreneur; this would mean chaos. We want somewhat more entrepreneurs; how many more is not clear. Importantly, we want

more *effective* entrepreneurs. What firms really want is proactive employees who take initiatives engage with colleagues and move things forward, convince colleagues and focus their energy on worthwhile projects. The terms "intrapreneurship" and "corporate entrepreneurship" refer to an entrepreneurial spirit, which remains within the limits of the corporate system. Corporations seem keen to work with very young companies, in the hope that their entrepreneurial energy will "infect" their corporate bureaucracies. One may be sceptical about the success of such endeavours. Furthermore, the start-ups are uneasy about such encounters, as they fear that their ideas may be stolen by the corporations. On the other hand, the corporate world must definitely learn to deal and interact effectively with start-up companies.

At the macro level, an indication of a country to have an entrepreneurial outlook is given by the ranking of the Global Entrepreneurship Monitor. Its 2017 report may be downloaded from www.gemconsortium.org/report. According to this, the most entrepreneurial countries are Estonia, Israel, the United States, Canada and The Netherlands. In Europe, Switzerland is in the upper range, at the level of the UK. Only 15 to 20 percent of start-ups are led by women. Rankings, however, should not be taken at face value. Their merit is to stimulate debate and discussions in an attempt to better understand the issues.

Implications for management

We have reviewed the characteristics and motivational aspects of technical professionals. We now turn to what these mean for management: what values, management styles and practices are most appropriate to motivate technical knowledge workers.

"Our staff is our most precious asset": often an empty phrase

Annual company reports are replete with motherhood statements on "people empowerment" and "the most important element is our staff". Companies are like individuals: they do not truly practice what they know is good. One example is the level of effort taken by a firm to evaluate a modest investment, say Euros 200,000, while it is often negligent in hiring new staff, which is the most important process in firms. It seems that spending money requires more attention than careful hiring. And yet, a mistake in hiring will cost the company enormously – but there are no "metrics" for this.

An indication of this misplaced priority is given by the generally poor welcome of new hires on their first day at work. This is irresponsible, since the first weeks on a new job strongly influence the motivation of the new recruit for a long time. First-line managers must be particularly attentive. A variation of the following fable, illustrating some of the pitfalls, has been published (Haour, 2004).

After obtaining her doctorate in computer science, Dr Joanne Talent vacationed in Yunnan, China, before starting her new job at Hubritech Corp., in Austin, Texas. On a balmy September morning, Joanne "reports" to work. No, the receptionist is not aware of her arrival; after contacting the personnel department, it turns out that her name is indeed in the roster of the staff. She is therefore allowed in, asking for Joe, her boss in the R&D department. Joe is nowhere to be found and does not answer his cell phone; he does not have an assistant, so Joanne goes from office to office to try to locate either her boss or where she has her desk and computer. Finally, she runs into Isabel, who participated in one of the interviews and who invites Joanne to a cup of coffee at the cafeteria. There, they run into Joe, who seemed to have forgotten all about Joanne's arrival. From then on, things began to get organised for Joanne, but what a disastrous

first impression! It is common sense that new hires should be tactfully welcomed and taken care of, with their new office and project work organised.

Contrasting with this calamitous behaviour, Laura, another manager from the same firm, had the habit of having the new hire share her office for a few weeks in order to accelerate the information exchange and integration of new staff. Also, she organised a welcoming party for each new hire as a sign of welcome and to accelerate the introduction to the staff. Laura's colleagues congratulated her for her good practices, but none of them followed her example. Most human organisations do not provide an environment that encourages "borrowing with pride". This is due to insufficient engagement and little encouragement by the higher echelons of management to proactively spread best practices.

More broadly, corporations are generally perceived by young people, particularly in Europe, as treating their staff poorly, largely as a result of the financial tyranny to satisfy shareholders. As a result, much young talent refuses to be salaried and chooses to become freelance professionals. The Internet is a key enabler in this. If an employer only commits to try to make you "employable", to use a common phrase, then many youngsters prefer to take the risk for themselves and be free from the managerial morass. Complacent corporations do not seem to see this a serious problem (e.g. being deprived from having access to a lot good young talent).

The famous "innovation culture"

"Innovation culture" is a catchall phrase. It conveys the idea of risk taking, openness, curiosity, "benefit of the doubt" and a positive, inclusive attitude. It denotes an environment in which novel ways and ideas are welcome and flourish. Such an environment takes a long time to develop; it can be destroyed in a short time. It may be enhanced, but doing so takes sustained and consistent effort over a long time and with the support of top management. In what I call an "innovation journey", I work as an adviser with companies towards that objective.

The region's environment has a role to play. There is the glamourous, much-talked-about Silicon Valley. There is also the region around Cambridge, UK. As indicated, a combination of an ethos of trust, a few powerful role models of successful professors-entrepreneurs and a first-class scientific and technical university, the so-called "Cambridge phenomenon" started with the St John's Innovation Centre in 1987. It developed over a period of 40 years. In 2018, a region in a 30-km radius from Cambridge is home to 4500 firms employing close to 80,000 people. This indicates that the average size of the firms is small. A rare company, the designer of chips ARM, grew to more than 5,000 employees in 2018. It was bought in 2016 by the Japanese company Softbank, for more than £23 billion.

In the 1990s, the company 3M was mentioned as having an "innovation culture". No single fact or policy could be taken as the cause for this. In innovation, as for many managerial matters, there is no panacea, as discussed later.

All policies must support innovation

These days, when asked "what is the most innovative company in the world?" executives are likely to answer "Google". As the largest advertising firm in the world, this company has "deep pockets" and plays with numerous developments; many of them fail, as documented on the Web.[9] The firm Tencent in Shenzhen in the ultimate Internet country, China, is the upcoming leader in this area.

In innovative firms, ways of doing things, practices and policies, incentives, etc., all must be "aligned" to support an innovation-friendly climate. It starts with selecting the new hires. In

order to attract more entrepreneurial candidates, a corporation may create an incubator for start-ups. British Telecom did just this, with its "Brightstar" incubator, in Ipswich. Generating and maintaining an "innovative culture" importantly includes personnel policies, rewards and incentives, rules for promotion, etc. Every element must be evaluated and fine-tuned so as to favour innovation. China as a country is obsessed with achieving this at the national, provincial and municipality levels (Soiz, 2017; Haour and von Zedtwitz, 2016). This contributes to accelerate the rapid progress of China towards becoming a main source of innovations for the world.

The walk-around manager

We have seen that technical knowledge workers must deal with the stress of uncertainty. Indeed, there is also considerable uncertainty in the business side of the firm – more than ever in these times of rapid change and global competition. In addition, however, leaders of innovation projects must blaze the trail and face uncertainty in the technical realm.

This situation requires that the direct managers show empathy to the staff. It helps if the manager has been a researcher in the past, preferably a "master of the craft". A non-technical professional is unlikely to be respected by technical knowledge workers over the long term. A positive policy is to rotate the R&D manager to a business job before coming back to the R&D function. Empathy is not enough. The direct manager must be following the progress of the project and bring a positive contribution, with comments and suggestions, in order to help project leaders accelerate the transition towards the markets. This involves suggesting colleagues make use of appropriate publications or conferences, which would help the project leader.

These requirements point to the fact that first-line managers must have daily interaction with project managers. This "walk-around management" is most appropriate to lead and motivate technical knowledge workers. Indeed, one dimension of this perspective is for managers to act as coaches, as discussed next.

Managers-coaches develop project leaders

One widespread scarcity found in companies is the lack of effective leaders of innovation projects. This is unfortunate, since the success of certain projects is key to the well-being of the firm. Developing project leaders requires commitment over the long term, sustained effort and timely rotations, etc. All these things are not well done in our short-term, financially driven corporations. What is needed is that project managers are "mini CEOs" (i.e. individuals with general management capabilities). This is even more acutely needed, as projects increasingly involve many different actors, as discussed later.

As indicated earlier, management often hesitates to stop projects. The result is that companies have too many innovation projects under way. This leaves the real key projects with insufficient resources and managerial "muscle". Furthermore, in recent years, the complexity of innovation projects has dramatically increased, as they must now gather several actors. Figure 20.2 shows the historical trend.

In the OECD countries, at the end of WWII, innovation was centred on science and technology, as implied by the phrase "technology push". At that time corporate laboratories were located "in the woods", away from manufacturing and from customers. Inspiration came from the breakthroughs of an all-powerful science: radar, jet engine and rockets, nuclear energy, advanced materials, etc.

Circa 1960, "marketing" appeared *en force*. Offerings had to satisfy customers in competitive markets. This demanded a more concerted, broadly based effort; hence the multi-functional

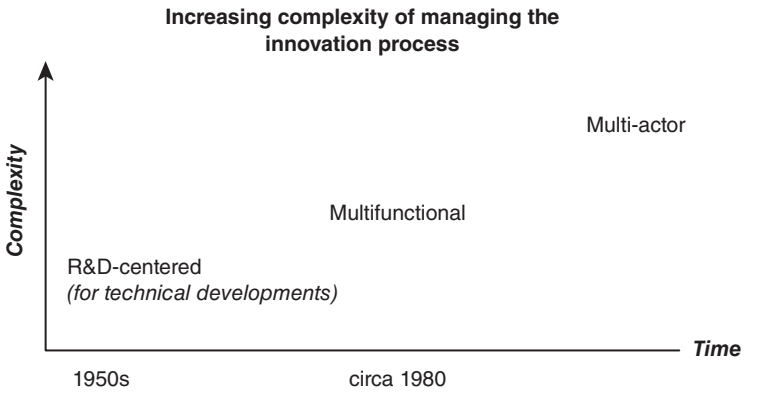

Figure 20.2 Increasing complexity of managing the innovation process

innovation projects. These involved primarily R&D, manufacturing and marketing. It was – and still is – difficult to operate true multi-functional activities. In fact, the innovation process really involves all parts of the firm, including the top executives and the board.

Because of acute competition and the need to be faster, in the late 1980s, it became necessary to increasingly involve partners external to the firm: other companies, SMEs, start-ups, universities and public research laboratories. This was initiated particularly in the area of mobile telecommunications and information and communication technologies (ICT). This is part of what is sometimes called "open innovation", as though innovation had ever been closed. This requires extensive transfer of technology and knowledge, which is a complex process, as will be discussed in the next section. Multi-actor innovation projects constitute an element of the "distributed innovation" approach, first described by Haour (2004) and illustrated in Figure 20.3.

This approach puts the entrepreneurial spirit of the staff in the centre of the firm, that is, a strong orientation towards the market in order to develop so-called "high impact offerings". This means that by proactively anticipating customers, the company comes up with offerings that are differentiating, and, it is hoped, commanding higher prices as a result, as well as slower price erosion. What is sought in this approach is not cheaper, but more *effective*, innovations. Such *high-impact offerings* are defined in the course of internal workshops and mobilising the company staff, who is the best and most knowledgeable to do the job when properly motivated and led. This involves a dynamic of workshops and conversations across various functions of the firm, effectively "facilitated" by managers or the staff. Indeed, a firm should embark on such a process only occasionally (every few years, or so), or it may involve one or two business units. Otherwise, the firm may be "excessively stimulated". In this process, the human factor is indeed key.

As already emphasised, companies lack effective leaders of innovation projects. As the latter increasingly become *multi-actor*, the situation grows even worse. Such leaders require a good knowledge of technical matters, must be business/market literate and good with people in multi-cultural settings. It takes a long time, as well as sustained effort, to develop such profiles of "mini CEOs". Part of their development should include short-term assignments in various functions and locations of the firm. To be effective, this "short-term expatriation" must be carefully prepared by managers on the sending and receiving sides of the traineeship. A good example is the Swiss company Bühler, producer of machinery for the food industry. This company is committed to running an effective international apprentice programme.

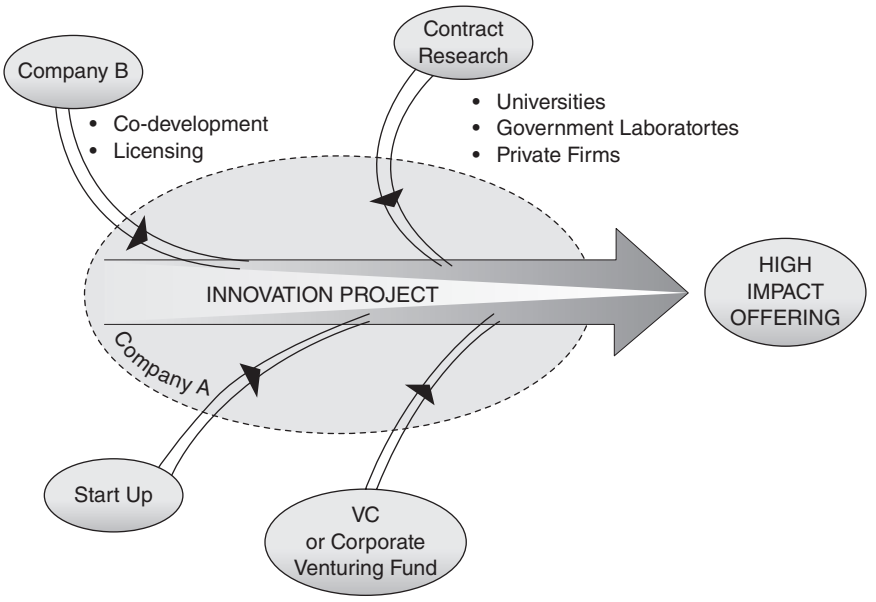

Figure 20.3 Entrepreneurial development of the offering draws on sources of technology distributed inside and outside the firm

The low attention of management for the development of staff beyond the traditional executive development, as well as the high turnover of employees, runs against achieving such long-term development. It is unfortunate, because effective leaders of multi-actor projects are difficult to replicate, giving the firm a clear competitive advantage. An exception is constituted by Japan, where lifetime employment is still largely the rule in large corporations, thus allowing long-term development of project leaders, including their wide rotation in various parts of the firm.

The role of top management in the human factor is candidly described in the book *Science Lessons*, by Gordon Binder (2008), former CEO of the biotech company Amgen. The author draws on his experience to explain his commitment and actions towards building effective teams, as well as hiring and retaining talented people. He also stresses the importance of the company's values and to "walking the talk" about them every day.

We now turn to an element of technical innovations, which consists of transferring knowledge and technology from one institution/public laboratory to a private company, with the objective of enhancing its competitiveness and creating new activities and jobs. In this activity also, much of the success much depends upon the talent and motivation of the staff.

The people-centric process of technology transfer

One vehicle for technical innovation is to transform the results of research carried out in universities or public laboratories into new, job-creating activities. Going from scientific results to business constitutes an extremely complex journey. It requires an understanding of business and markets, in addition to mastering the implications of technical intricacies and IP issues, not to mention the people aspects. In fact, it is one of the most complex processes on earth (Haour and Miéville, 2011).

How central the human factor is in the art of technology transfer is illustrated by the difficulty in turning public laboratories into customer-oriented contract research. Between the 1940s and the late 1980s, the Atomic Energy Research Establishment (AERE) of Harwell, south of Oxford, was the main centre for nuclear research in the UK. At that time, it was decided to open the activities to external clients and the projects appropriately concentrated on R&D/consulting in the environmental sciences. This turned out to be a very challenging transition, as the professionals concerned did not have the skills or the motivation to present their capabilities in ways that would attract firms' funding. Many engineers left until the staff was reduced to fraction of what it was. The decision was then made to invest and turn the site into an innovation centre, with various laboratories and technical activities. In 2012, what was left of AEA was sold to Ricardo, a consulting engineering firm with 2,900 professionals, to become Ricardo – AEA, centred on environmental technologies.

Other examples of this difficult transition are CSIR in both South Africa and India. In the latter case, in the late 1980s, a sustained attempt was made to make government laboratories more relevant to industry and society as a whole. It was hoped that the various laboratories would develop collaborative work and licensing activity with firms, such as Tata or Reliance. In spite of the considerable energy deployed, this transformation did not take place, again, as a result of the staff's insufficient skills and motivation to move down that road. In the best of circumstances, such a transition takes more than five years, such as in the case of CSIR in South Africa.

As a result of the complex nature of the technology transfer process, but also because universities and firms constitute two very different worlds – as it should be, such collaborations between these two worlds are not as extensive and effective as they could be. However, there exists a very broad range of activities connecting these two worlds, as illustrated in Figure 20.4.

The most powerful vehicle for technology transfer is through people (i.e. the hiring of university graduates by firms). As is often said, transfer is best done by moving people. Historically, examples include the forceful transfer of experts in porcelain making from Meissen, near Dresden, to Berlin by Frederick the Great in 1756. The next sections look at the three main channels for technology/knowledge transfer: collaborative research, licensing and spinning out new companies.

University-firm collaborative research

A key channel for a firm to tap into expertise available in universities is to fund R&D projects carried out by a team from that university. Companies use this vehicle more or less intensively. A company like Hewlett Packard routinely has more than 100 collaborations in place with universities; quite a few of these involve Chinese universities. Pharmaceutical companies are practising it the most, because they need to complement their own unproductive drug development pipeline by accessing new molecules and devices found in universities' medical research programmes.

In contrast, SMEs do not use university collaboration much. This is particularly the case in Switzerland. In an attempt to remedy this situation, the Swiss government has created a chain of higher schools (*hautes ecoles*), who are especially tasked to engage with SMEs in order to help them become more competitive over the long term. Again, as stated elsewhere, "helping" SMEs develop their activity by better leveraging global markets is the safest way to create jobs back home.

Research directly funded by firms in universities/public laboratories represents a mere 7 percent of the total research budget in the best research-intensive universities, as shown by the work carried out by the OECD in Paris (2017). Some universities wrongly include in the numbers of

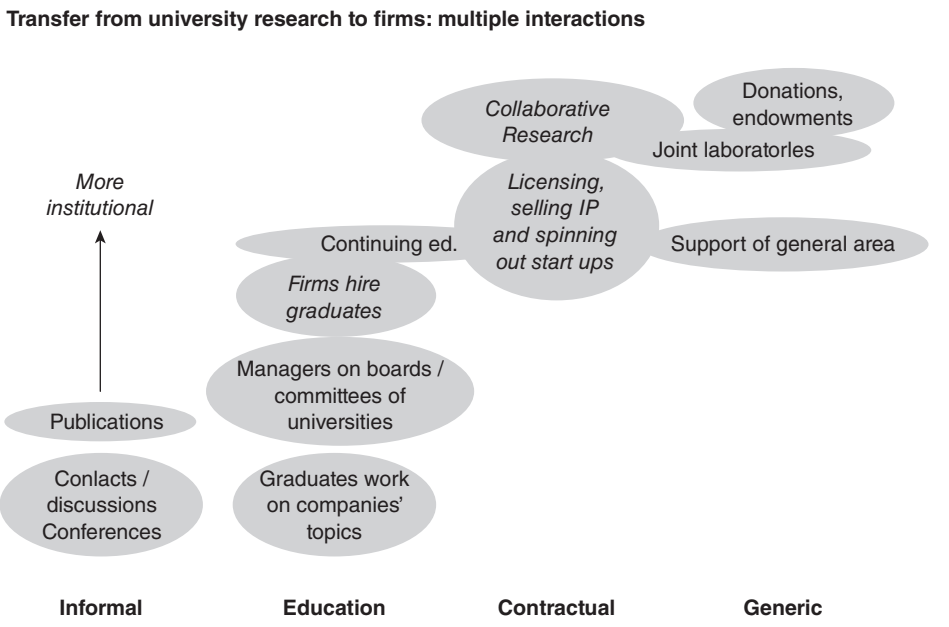

Figure 20.4 Firms engage with universities in many different ways

external funding the matching public monies provided by government grants. The lion's share (93 percent) of university research is funded with taxpayers' money.

Collaborative work

Most frequently, collaborative research is carried out on a one-to-one basis. Often, the technology transfer office (TTO) is putting the two parties in contact; its role of facilitation, as a "middle person", must not be in the way of both sides having a productive dialogue. This will be further discussed later.

The firm and the university team must spend enough time together discussing the issues and the proposed work to address the issue so that they establish a good understanding concerning the business goal, as well as the risks attached to the proposed project. Given that business and university constitute two different worlds, it is important to spend enough time on that phase. This considerably reduces the risks of misunderstandings, thus increasing the chances of success of the project. In the course of these discussions, both parties often *redefine* the issue and objectives as a result of fresh input provided by these conversations. The proposal also results from these discussions. A corresponding contract spells out intellectual property rights, budget and payments, and other administrative matters.

Once the contract is signed and the project begins, it is important that, following the relatively intense period of negotiations, both parties do not excessively reduce their interaction, as it so often happens. The project manager following up on the progress of the work, involving abundant and frequent two-way communication with the client, will avoid many subsequent disappointments and pitfalls. One of the many qualities of a good project manager is that ability to effectively communicate in a timely way.

On the other hand, several firms may join together in funding a project in a university or research lab. Such "multi-client projects" are practised by contract research organisations, such as

Battelle, to investigate a common issue. In this way, the cost of the R&D programme is shared among the participating firms. It may be a good way of assessing the merits of a new process, such as 3D printing or blockchain, for example. If patent material is developed in the course of the project, great care must be taken at the proposal/contractual stage to clearly define the IP rights of each participant. A type of multi-lateral project is carried out as part of the Horizon 2020 programme of the European Union, as discussed earlier, pointing out that such projects are the world's most widely diverse.

Students in firms

Involving graduate students in the R&D activities of a firm constitutes another channel for transferring knowledge and technology. As an example, each year, the German firm Bosch invites roughly 100 students to come to work as trainees in the company. During this period, they are guided so as to provide an effective contribution.

SMEs may well benefit from such internships. Several countries (Holland, Singapore and Switzerland, for example) have instituted *innovation vouchers* in order to jumpstart such collaborations. Small amounts of money (less than 10,000 euros) are put at the disposal of the firm on the basis of a proposal involving work to be carried out by a graduate student. The process is non-bureaucratic and typically Internet-based. Oftentimes, the student is hired by the SME.

Collaboration in non-technical areas

Firms rarely tap into university knowledge in non-technical areas. This is somewhat surprising, since so much of business success depends upon societal, non-business issues, and this is more and more so. Social sciences, such as anthropology and sociology, may well help better understand certain areas, such as the acceptance of new technologies or the person–machine interface. Closer to traditional firms' need to "listen to the customers", *ethnographic marketing* attempts to monitor the behaviour of customers in their interaction with products. This is often at the origin of improved or new designs of the offerings by the firm.

When doing business in China, firms should have a reasonable knowledge of that country's history and culture, which the business partners will appreciate. Universities can provide such knowledge in the course of appropriate educational programmes for managers.

Summary on collaborative R&D

Indeed, the primary missions of universities are excellence in teaching and excellence in research. By transferring their knowledge and technology to firms, however, universities fulfil an additional mission while providing precious input to society. Furthermore, resulting interactions with firms provide healthy stimulation and inputs to university personnel. In fact, it is generally accepted that the better universities are also those which are most active in collaborating with the private sector.

As mentioned, SMEs do not benefit enough from such collaborations. Partly because they are less well prepared to make use of them, mainly due to the lack of understanding and people capabilities to transform technical ideas into useful activities and improvement of operations. In the United States, the small business industrial programme (SBIR) is often presented as a model to force collaboration/business dealings with SMEs. In China, the Torch programme is specifically designed for SMEs. Helping SMEs become more competitive and to better benefit from global trade and markets is probably the safest route for a country to create jobs. This is done

with money, of course, but mainly by helping provide them with the proper skills and people, managerial practices and approaches. "Young retirees" may provide such contribution.

Licensing

Research carried out in universities and public laboratories often lead to the filing and sometimes granting of a patent. The strength of the patent is its resilience in defeating the challenge from another patent in a suit, but mainly as the basis for creating new activities and commercial applications. The vehicle for the transfer is patent-based licensing.

Successful licensing demands good knowledge of the industry and of the markets, as well as an ability to dialogue with managers in order to explain the contribution of the contemplated deal. This also requires knowledge of the licensing "mechanics".

Professional associations such as the Association of European Science & Technology Transfer Professionals (ASTP-Proton) and the Association of University Technology Managers (AUTM) in the United States group practitioners in this area. More generally, the Licensing Executives Society (LES), headquartered in London, has members in many countries who regularly meet in order to facilitate exchanges and contacts.

The world's total licensing activity (down payments and royalties) represents more than 200 billion euros per year. The United States has the largest share – more than a third. Paralleling the growth of trade and exchanges, this number has grown in recent decades. There are several years between the granting of a patent and the ramping up of royalties derived from it. The share of university licensing represents a small percentage the total, but is not an insignificant amount.

Having a strong patent constitutes a prerequisite. The rights and ownership of the patent must be clear and straightforward. Otherwise, potential investors will not engage in a negotiation. In the United States, in 1981, the Bayh-Dole Act simplified matters by entrusting the university with the ownership of patents derived in the course of publicly funded research. Universities may then sell rights on the patents in an exclusive or non-exclusive way.

In the (usual) case of a product patent, many elements must be dealt with, starting with scouting for the appropriate company prospect. Then, preparation must be done prior to conducting negotiations on the size of the market concerned, the impact of the innovation proposed, the field of use, the geography concerned, the royalty rate, etc.

University licensing offices must not aim at maximising revenues from licensing deals. They should license to the firm that offers the most chances to best develop its activities as a result of the license. Job and value creation are the criteria for success of the TTO. Indeed, close to 90 percent of university licensing offices do not generate enough revenues to cover their expenses. This should be no problem, as long as the impact to society is substantial.

There are occasional large licensing deals, usually in the life sciences sector. These multi-million "blockbusters" reported in the media give the impression that university licensing is a gold mine. It is, but only for a very small number of deals per year.

University spin-offs

Creating a start-up company constitutes the third channel to bring firms the results of research carried out in universities and public laboratories. This is the most difficult and risky path. All over the world, whether in Cambridge, UK, or in the "glamorous" Silicon Valley, success rates are similar: only 25 percent of technical start-ups survive after five years. Making the transition from technical work to a successful company is highly difficult and complex. Figure 20.5 illustrates the steps along this path. Each step requires a highly competent and up-to-date advisory council.

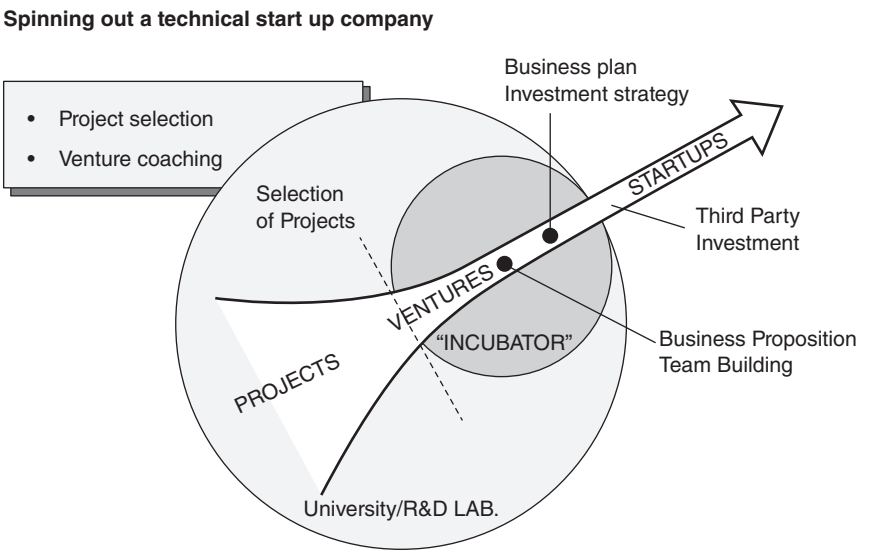

Figure 20.5 Steps in spinning off a technical start-up company

Launching a start-up

The origin of a technical venture is in the laboratories. Typically, university staff is not very knowledgeable about markets and business or management. Therefore, forming a new venture most likely requires a third party be involved who brings the relevant commercial knowledge. Projects carried out there must be steered towards commercial applications. The ventures presenting the most potential are selected by a board of persons familiar with the technical and business aspects of the ventures.

Alumni of the universities may provide such know-how. For example, this is the case of Imperial Innovations in London. This outfit is somewhat unique, in that it is an incubator/accelerator listed on the London Stock Exchange; it concentrates on making money via spinning firms emanating from Imperial College's research, but also from other sources in order to have a sufficiently abundant deal flow.

A key factor for the success of the venture is the quality of its team. Entrepreneurs are like "babies in the wood"; they need advice, guidance, suggestions and, most importantly, they need to be challenged with difficult questions. What is really distinctive in your offering? What is the competition to your approach ? How robust is your business model? How about the intellectual property aspects? Also, business contacts and referrals are suggested to the team. Venture capitalists (VCs) primarily look at the quality of the team, and, when they invest in the venture, contribute business help and support to that team. This is what is called "smart money". Again here, the human factor is a dominating element.

This "coaching" activity is usually done in an "incubator", which aims at accelerating the launch and development of the venture. The value of an incubator is not in the building, laboratories and reception desk. It is in this business coaching and in the learning taking place among the various entrepreneurial teams hosted in the incubator. Indeed, these contacts, as well as discussion forums and informal meetings, must be prompted, catalysed and organised by the coaches.

Over several months, this "on-demand" coaching progresses from managerial issues, value proposition, business model, hiring new staff and IP strategy to looking for financing. The coach helps with formulating the business plan and the requests for funding, as well as with specific sources of financing, such as venture capital firms and "business angels". It may include public funding. The start-up may reach the stage of an "exit", that is, either being sold to a company in a trade sale or, more cumbersome but potentially more lucrative, being introduced to the stock exchange via an initial public offering (IPO).

An example of such a value-creation process was the British Telecom's "Brightstar" in Ipswich, UK. Attached to one of BT's corporate laboratories, Adastral Park, it aimed at exploiting the know-how and patents in specific areas of this laboratory, whose staff was ready to take the challenge to transition from researchers to entrepreneurs. A number of coaches, knowledgeable about the business and this process, were hired to accompany the teams along this transition over a period of months. A total of 15 firms were thus spun off from the laboratory.

Because of the arduous process of turning results of research into commercially viable ventures, the spin-off route must be used as a last resort, when it is clear that it offers the best route for creating value. Also, the company should not be incorporated too early. A key requirement is to have a quality team eager to make the venture a success. If not, licensing out, or collaborative research, must be preferred, and a licensing deal often constitutes the link between the university and the new venture, as the start-up is a licensee of the university.

Universities' business schools should apply their expertise to the commercialisation of knowledge and technology. Indeed, it is not enough to launch start-ups; it is important for them to *grow*. In this area, the United States is performing well, with numerous ICT firms, such as Microsoft, Oracle, Cisco and eBay having rapidly grown to become dominant actors in their industries. China is truly outstanding in its ability to rapidly grow companies. In contrast, Europe's young companies seem to have what this author calls the "Peter Pan syndrome".

China's innovation is relentlessly people-centric

China is rapidly becoming a major source of innovations for the world (Haour and von Zedtwitz, 2016). Its entrepreneurial energy and agility, as well as its relentless business and customer orientation, are remarkable. Chinese entrepreneurs have an uncanny ability to extract value from an activity. Also, the support from the public sector for innovation and entrepreneurship is unfailing at the national, provincial and municipal levels. The large Chinese market, which is highly competitive and demanding, provides a very formative environment for young ventures.

Many practices and policies show that China sharply realises that talent and energy are central to the success of innovation. A first indication is the great effort put in attracting and welcoming the returnees from outside China (about 400,000 each year). Science parks, incubators and business accelerators throw open their arms to them, with staff, guidance, subsidies, tax breaks and services. Second the "Thousand Talent Programme" is a government programme to attract experts in various areas, especially in fields where China has ambitious plans but few professionals, such as the aircraft industry and its maker of civilian planes, COMAC. Third, the extremely vibrant scene is in Shenzhen, where start-ups, SMEs and large firms alike, such as Tencent, Huawei and Foxconn, collaborate and do business alongside the dynamic "makers" movement.

In addition, China puts a lot of attention on education, which demands many improvements, as is the case in numerous countries. There is a strong effort to boost existing universities, as well as to create new ones.

Conclusion on the crucial human factor in innovation

Innovation is not about quantity of input, but about *effectiveness* of output. The amount of R&D investments only constitutes a rough measure of the level of innovation of a firm, or of a country. Companies may invest large budgets and have no useful outcome except for the knowledge acquired in the course of failed projects, which will be useful for the next one. The "innovation crisis" in the pharmaceutical industry illustrates this. Increasing investments are made for drug development, while the number of authorised drugs has been decreasing in recent years.

Ultimately, innovation is a people-centric process. The key determinants of the effectiveness of the innovation process are the talent and the motivation of the people involved. This constitutes the "crucial human factor". To fully focus on the individuals, management must truly engage with technical knowledge workers.

A similar challenge is encountered in a specific element of the innovation process, that is, the transfer of technology/knowledge to turn the results of university research into new activities and jobs. There also, the success of universities' TTOs is predicated upon the quality and competency of its staff along several dimensions. These include technical literacy, business sense and market knowledge, ability to communicate in both "techno speak" and "business speak", and the ease in handling these three channels of technology commercialisation. This means that TTOs must be carefully staffed with sophisticated professionals. Having well understood this, Switzerland acted accordingly and reached the top place in the world for effectiveness in technology transfer in less than 15 years (Haour and Miéville, 2011).

In addition to being very carefully selected, such professionals must receive timely training in IP and technology commercialisation. Specialised, short courses, combined with *apprenticeships*, must be used to accelerate the development of the staff (EPO, 2017).[10] Young TTO officers should occasionally spend time as trainees, just like when they were students. By learning about specific cases from experienced colleagues, they enrich their experience, as well as their confidence to deal with future situations and to communicate with colleagues effectively. A comprehensive manual on technology licensing is given by Cannady (2013).

In our times of financial tyranny, management tends to lose the common-sense notion that low motivation among staff represents a huge cost. Firms focus attention on processes and practices supposed to bring profits, but do not properly consider the crucial human factor. Corporations talk about "brand equity" but no equivalent attention is brought to "staff equity". In listed companies, managers are often *not really engaged* with the staff. They operate in a world of financial "short termism". Hopefully, Chinese companies will not fall in this trap. Family business, private equity firms (i.e. non-listed) and cooperative companies are more detached from such short-term financial pressures, and, as a result, they show more attention to the human factor.

Concerning the process of innovation, there are numerous tools and practices and consultants' recipes pretending to boost its effectiveness. More important than such "old wine in new bottles" is to focus on enhancing the contribution of *individuals*, as well as their ability to work with colleagues effectively. Their talent, motivation and energy are the ingredients that allow innovation to flourish. Through true and sustained attention to these factors, managers bring considerable value to their firm by carefully identifying, selecting, retaining, developing and motivating staff. This time-consuming task demands considerable engagement, while maintaining *trust*. Managers must *take the time* to carry out this task with full commitment.

Notes

1 www.ukspa.org.uk/members/sjic
2 www.oecd.org/site/cfecpr/EC-OECD%20Entrepreneurial%20Universities%20Framework.pdf
3 https://euipo.europa.eu/ohimportal/documents/11370/71142/The+Global+Innovation+Index+2014
4 www.ecowatch.com/plastic-ban-uk-2534089763.html
5 www.history.com/topics/world-war-ii/bombing-of-hiroshima-and-nagasaki. February 2018.
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