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Evolution and Impact of Advanced Technologies on Humankind and Business

1.1. Introduction

The "new technologies" considered hereafter are related to the general concept of NBIC (Nanotechnologies, Biotechnologies, Information technologies and Cognitive sciences). They anticipate the emergence of any improvement that affects human performance and sustainability, our lifestyles and the way we will act in the future.

Therefore, it is very important to describe this new context, where ethics will play a role of key importance. More specifically:

– this chapter will show how the environments of both business and humankind will evolve: where we are going and what the benefits of new technologies for human beings will be;

– to better understand the relationships we will have between ethics and artificial intelligence, in terms of task optimization, transhumanism, Asimow, etc. (Chapter 2);

– to better understand the relationships we will have between ethics and uberization, logistics, transportation, the shared economy and new work organizations (Chapter 3);

– to better understand the relationships we will have between ethics and social networks, the sharing of ideas, the economy of sharing, the emergence of new needs and innovation, the new modes of working based on cooperation and collaboration (Chapter 4).

It is also important to note that the more we work with the basic biologic systems and the nanomechanisms available in the nature, the more we will be able to go further in the evolution of humankind and our life principles.

For instance, to explain such a paradigm change, we will take the example of the DNA. Many scientists know that the DNA is much more powerful than any computer program: however, how can we apply this capability to our daily lives? There are, in fact, two possibilities:

1) The traditional approach consists of developing new computer programs, taking into account the way a living organism works through mimicry. Therefore, we could develop ANNs (artificial neural networks) to perform classification, clustering or ranking activities in decision-making. ANNs are very useful for deep learning and to develop cognitive robots. There are also genetic algorithms, simulated annealing techniques that can be used to optimize solution search, improve our immune system, control evolutive situations or develop adaptive programs. At last, the study of ants or colonies of bees (collaborative social animals) enable us to see how a collective intelligence can emerge, how we can build a complex structure, etc. In fact, in all these examples lies a transposition of some underlying mechanisms from one field of sciences to another.

2) The new approach consists of remodeling a problem and adapting it to the capabilities of the living DNA organism. Here, it is not mimicry (from information to biology, or vice versa); we use the Turing machine properties of the DNA (molecules or biological structures) to directly exploit a kind of living being computer capability [ROQ 16, DEL 17].

Here, we face an ethical problem different to the one of bioethics or advanced sciences exploitation: we cannot adapt or change something like Mother Nature in order to solve one of our problems, but we entrust to nature the care of defining or finding the solution. We no longer have control of the algorithm!

1.2. Evolution of technologies

In our global world, the way business is conducted is of a dynamic and unforgiving type. Competitiveness is increasingly acerbic (often due to greed) and requires us to be reactive and to protect our business sectors with more and more vigor.

Some people are aware of the need to continually adapt our strategies and ways of thinking. We often talk about new technologies or a "technological revolution". In fact, as with the industry, IT is used mainly to automate and formalize existing processes, to save time and to put rigor (e.g. traceability, information control, etc.) into our practices. This desire to improve our processes is already a progress in itself, but it is not enough.

To clarify, it is worth pointing out that in our economy, industry in particular has already undergone many changes and innovations over the past century. We will not go back in time to explain this evolution, but we will focus on what is most important.

During the last century, the industry evolution was subject to five disruptive changes:

1) Mechanization. By the end of the 19th Century, the development of coal and steam engine energy directly fostered the mechanical and textile industry.

2) Agro-chemistry. It is the result of advances in the development of industrial chemistry and war chemistry (bacteriological) that have generated a multitude of new molecules, which have also allowed (by adjacency phenomena) us to positively evolve our practices (in the sense of the general interest).

3) Intensive production. After the Second World War, for strategic reasons (but also economic, geopolitical, etc.), the industrial metamorphosis addressed all the sectors of our economy as well as our society itself. It is the source of productivity and quality.

4) The 1990s and genetics. Just as we know how to control our environment, it is now possible to control the welfare of living species. Quantitatively, qualitatively, and also from sanitary or phytosanitary point of view, it becomes interesting to modify the chromosomal nature of the species. Just as one knows how to make a clonal selection at the level of plants, since GMOs (genetically modified organisms) appeared in 1985. We are entering the era of transhumanism with all the consequences that one can foresee in terms of the benefits for our living species, the evolution of the world and the risks that can arise from this.

This, of course, raises ethical and risk management issues, but it would be good here, rather than adapting a blocked ideological posture, to analyze the in's and out's, risks and benefits, and then to "manage" the situation in a slightly more intelligent way.

5) The present. Since 2010, a new step is being taken with the Industry 4.0 plan of progress. The action plan is based on five factors: (1) the agility of the production system (dynamic volume flexibility); (2) the collaborative working mode and the human factor; (3) a high flexibility (product variability); (4) lean manufacturing to produce more with less resources; (5) optimization or best usage of resources and decision making.

The implementation of the Industry 4.0 concepts "naturally" implies innovations to be carried out through a large usage of new technologies. In order to simplify this integrated concept, I would call that universal and global concept: "High Precision Technology".

It requires a combination of key technologies referred to as NBIC. NBIC refers to a set of complementary technologies: Nanotechnologies, Biotechnologies, Information processing and Cognitive sciences. In other words, Computer Science, Big Data, Internet of Things (IOT), Internet of Everything and Cognitivism (signal processing, knowledge management, artificial intelligence, deep learning). Indeed, they are implemented in the best sustainable way in different tools; we can quote: robotics, sensors, drones (unmanned aerial vehicles (UAV)), tablets and computers, Watson, etc.

However, talking about "Industry 4.0" is not easy:

– About the technologies to be used, we can state that a lot of advances are still expected to fulfill the requirements and the objectives defined by the executives. To be more specific, and focusing on ethics, we will remind (at this stage of Industry 4.0) the following domains to be enhanced:

- semantic web and metadata;
- identity and security in the information system;
- biometrics;
- radio frequency identification (RFID);
- new generation of smart sensors;

- the geospatial web and geolocalized services;

- mesh networking and social networks;

- grid computing;

- new inspiring technologies: cognitive robotics.

– In parallel, the set of organizational problems to be solved either in logistics (mutual storages), distribution of production units, or PLM, etc. are related to: (1) global resource sharing; (2) security; (3) load balancing; (4) distance neutrality; (5) open standards. They require an acute sense of ethics.

1.2.1. *A challenge*

What is important here is the fact that we are in a collaborative world, with exchanges of big data, and that we are linked to the notion of hybrid systems: man/machine (hence the notion of transhumanism), and of working with interconnected systems (contrary to what one thinks, the collaborative systems are not open to cooperation but to a strong individual involvement and interest for what is done in a common and coordinated project. We will not debate here this aspect: it can be found in the social networking chapter).

To summarize and refocus on industry or transportation: installing a GPS system and an image processing system associated with a camera and a computer to move correctly between working stations is called “automation” and represents an improvement in itself.

In the field of production, design and assembly, the monitoring of devices and equipment, driven and controlled with sensors and programmable controllers allows us to better manage an activity. However, all this is local, partial, limited in scope … when applied correctly.

Since the 1990s, computer innovations have allowed us to learn everything about certain processes and have allowed us to adjust the practices, planning, scheduling and sequencing, and then to adjust the production parameters, etc. However, as said before, it is just process automation, and a limited use of the information system.

The digitization of our society means we are facing a huge mass of data (currently on the order of exabytes = 10×18 units of information, or even zettabytes = 10×21 are pasted and stored each year). The competitive advantage that can be gained therefore comes from being able to extract an added value from these data. The stakes are outsized because the data collected would generate social, agronomic, economic, technical, commercial, etc., values. Indeed, those who hold an influence and provide information on the networks are disseminated in nature, and their intentions must be able to be taken into account in developing products or services adapted to the context, needs and feelings of consumers. This allows us to understand the emerging needs, to automatically monitor the design and development of these customized products, with specific characteristics and packaging, in a reduced amount of time.

As we see here, we can do a lot of things to work differently with big data: many of the current formal steps will soon be obsolete; the marketing and commercial concepts, with their respective intermediaries, will gradually disappear from the economic landscape. To illustrate this, and focusing on the finality of a production, we will have to change our attitude: an assertion like "we do not produce at the top of a given quality level to sell" will become "we communicate and we sell to produce what will satisfy and best fulfill the happiness of a person who is feeling a kind of desire or a hidden need".

However, before this happens, conventional statistical methods will have to be changed, because current approaches often consist of making predictions based on a few parameters "p" on populations consisting of "n" individuals (sometimes, "n" exceeds several thousand individuals), whereas with big data, we are able to measure millions of parameters "p" associated, after a proper clustering or segmentation, with only a few hundreds of individuals. The problem is reversed! This also implies a new organization of production work, in order to develop more carefully, precisely and in diversified volumes a lot of different products (because the market is global).

Therefore, after the Industry 4.0 concept that is being implemented, we can perceive what the future will be: it will lead to new concepts (paradigms) that will also call for a new approach to ethics.

1.3. The United Nations: concerns and recommendations

A summary of infoethics concerns has been established by a working group of the United Nations Educational Scientific and Cultural Organization [RUN 07].

Technology	Possible Positive Effects	Possible Negative Effects
RFID	• Could bring efficiencies in the supply chain (boosting the standard of living, which some people see as related life, liberty and security). • Could increase security by augmenting enforcement capabilities.	• Could improve on freedom of religion if implants were necessary for participation in the Information Society. • Could enable extensive surveillance, impinging on privacy and other freedoms.
Sensors	• Could serve as life-saving devices directly related to the right to life, liberty and security of person). • Could help optimize production and distribution (contributing to efficiency and thereby life, liberty and security of person).	• Could breed uncertainty regarding the public domain and access to information and the means of communication. • Could cause governments to have sovereignty and security concerns. • Could enable extensive surveillance, impinging on privacy and other freedoms.
Geospatial web and LBS	• Could be viewed as helping people to exercise their right to mobility. • In extending the availability of emergency services, could enhance the right to life, liberty and security of person.	• Could hinder privacy through the tracking of location. • Could allow discrimination and the blocking of assembly and expression through the tracking of location.
Mesh networking	• Could disrupt content restrictions (eg, filtering or bandwidth alienation). • Could help poor regions have access to means of communication.	• Could concentrate power in Internet backbone connection points. • Could give rise to authentication problems (similar side effects as digital identity management tools (especially privacy).
Grid computing	• Could provide computing and data storage and retrieval for the poor. • By allowing resources to go where needed, would offer efficiencies.	• Could enable extensive surveillance, impinging on privacy and other freedoms. • Could allow discrimination and other restrictions given access chokepoints.
New computing technologies	• High-powered computing could allow translation and bridge peoples. • Ambient intelligence and computing grids could boost access.	• Could enable extensive surveillance, impinging on privacy and other freedoms. • Could disrupt geo-political balance (eg, by enabling encryption).

Technology	Possible Positive Effects	Possible Negative Effects
Semantic web	• Expands access to information. • Could cause polarization and lack of public discourse, though this is debated. • Brings efficiencies (boosting the economy and with it the standard of living, which some people see as directly related to the right to life, liberty and security of person).	• Could make it easier to block people from receiving various content. • Could make it easier to prevent people from imparting content (eg., thwarting certain content or competition supplied by new entrants). • Could put people on the same level as objects.
Digital identity management	• Could enhance privacy and security. • Could bolster freedom of assembly by helping people identify others with similar interests. • Could bring efficiencies and net web services free (boosting the economy and with it the standard of living, which some people see as directly related to the right to life, liberty and security of person).	• Could allow collusion and profiling by identity providers and relying parties. • Could easily be connected into a government control system. • Could enable discrimination. • Could cause humans to treat the mercy of machines (asked to act as agents). • Could intensify security risks of compromised computers.
Biometrics	• Could bring accountability, which some people see as tied to the right to life, liberty and security of person. • Could increase government's capacity to provide the public with governmental services (eg., speedier passport checks at airports). Some people would view this as promoting the right to life, liberty and security of person.	• Could be coupled with digital identity management tools as a pre-requisite for participation in Information Society activities. • Could lead to international system of control administration, but international bodies are not equipped to prevent the abuse of power. • Could enable extensive surveillance, thereby hurting privacy, freedom of association and freedom of expression, among other freedoms.

Table 1.1. *New technologies. A summary of infoethics concerns (Unesco 2007)*

Within this framework, the UNESCO recommends to use the following rules, presented as extracts from the Universal Declaration of Human Rights [UNI 48]:

– Article 2:

Everyone is entitled to all the rights and freedoms set forth in this Declaration, without distinction of any kind, such as race, color, sex, language, religion, political or other opinion, national or social origin, property, birth or other status. Furthermore, no distinction shall be made on the basis of political, jurisdictional or international status of the country or territory to which a person belongs, whether it be independent, trust, non-selfgoverning or under any other limitation of sovereignty.

– Article 3:

Everyone has the right to life, liberty and security of person.

– Article 7:

All are equal before the law and are entitled without any discrimination to equal protection of the law. All are entitled to equal protection against any discrimination in violation of this Declaration and against any incitement to such discrimination.

– Article 11:

1) Everyone charged with a penal offence has the right to be presumed innocent until proved guilty according to law in a public trial at which he has had all the guarantees necessary for his defense.

2) No one shall be held guilty of any penal offence on account of any act or omission which did not constitute a penal offence, under national or international law, at the time when it was committed. Nor shall a heavier penalty be imposed than the one that was applicable at the time the penal offence was committed.

– Article 12:

No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honor and reputation. Everyone has the right to the protection of the law against such interference or attacks.

– Article 18:

Everyone has the right to freedom of thought, conscience and religion; this right includes freedom to change his religion or belief, and freedom, either alone or in community with others and in public or private, to manifest his religion or belief in teaching, practice, worship and observance.

– Article 19:

Everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers.

– Article 20:

1) Everyone has the right to freedom of peaceful assembly and association.

2) No one may be compelled to belong to an association.

– Article 21:

1) Everyone has the right to take part in the government of his country, directly or through freely chosen representatives.

2) Everyone has the right of equal access to public service in his country.

3) The will of the people shall be the basis of the authority of government; this will shall be expressed in periodic and genuine elections which shall be by universal and equal suffrage and shall be held by secret vote or by equivalent free voting procedures.

– Article 26:

1) Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit.

2) Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace.

3) Parents have a prior right to choose the kind of education that shall be given to their children.

– Article 27:

1) Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits.

2) Everyone has the right to the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author.

A democratic Information Society must cover: The Legacy of Hierarchies, the wide and uncontrolled spread of Computing capabilities which are Extraordinarily Inexpensive, then Long Distance Proxi to Mobile, and at last things that Take Off, Scale, and Reinforce Themselves in anon equitable way.

1.4. Evolution of production systems

Production systems bring together many concepts which refer to operations management, industrial engineering, software programs used to provide administrative services, some form of artificial intelligence (transhumanism), retail industry, manufacturing and logistics, etc.

The goal of production has evolved over time. Now, with Industry 4.0, we can talk about mass customization and personalized goods and services. However, for a century, a lot of concepts have been defined and integrated in them.

The transition will be as follows:

Mass Production → Mass Customization → Mass Personalization → Mass Personification.

This last stage will be one requirement for the new Industry 5.0.

Personalization is a phenomenon currently observed in industry and administration. This often involves developing a product or service with options or external features such as shape, color and comfort functions as desired by the consumer or customer. This will also make it possible to adjust a pricing policy, or to introduce a new functionality or an innovation (whose essential utility is, first, to simplify a process).

Personification, as we have seen, is a much more subtle and psychological need [MAS 17b] that is not included in the Industry 4.0 and which we will not discuss in this chapter.

There is often, however, a gradual increase in the use of products by the customers: it depends on their income, the segmentation of the population (social or cultural strata), etc. This leads them to amplify, sometimes excessively, some expenses (related to comfort, culture, use, etc.) as soon they have a psychic impact on them (sensation of comfort, mood, happiness, etc.). At the level of ethics, we must ask ourselves several questions.

1.4.1. *Question: Innovation and usefulness*

The first question we may have is related to "utility". Indeed, ethically speaking, the objective is to create a product or service that is useful, usable and used.

When faced with a proposal for a solution or an innovation, and if one wants to evaluate the confidence level of such an opportunity, the intuitive and common sense approach must take precedence over mathematical rigor and marketing strategy: this avoids integrating, by force, "new" technologies that are not essential:

– The ethical and rational approach is: "I have a problem, how do I solve it?", "how may I improve the life of somebody?".

– In contrast, the marketing approach is: "I have a product, where can I sell it?", "sell it with a maximum of subscriptions"? Or rather … without added value, like a dream?

The objective is not to provide an additional concept of scheduled obsolescence in products or services with a limited lifespan, until one realizes that it is useless.

Some mathematicians have modeled the product lifetime (ΔT) as a function (Power Law of LM type – Newton Movement Law):

ΔT = Kh (human sensitivity factor) × GF (quantity of user "GeekFrime") × TP (information absorption rate)/Q (ability to challenge solutions)

1.4.2. *Question: Anticipation*

The second question we must always answer (sometimes, without knowing how) is: how do we anticipate a need, how do we personalize production, how do we personify specific needs associated with a real risk and its associated cost, according to the abilities and possibilities of each one? This brings us back to recent advances in social networking (or social innovation, as discussed by Pierre Massotte in [MAS 13]) and to the notions of emergence and costs in complex systems. In terms of macro-personalization, it should be pointed out that these are consumer goods or complex products whose manufacturing is close to being tailor-made (one-of-a-kind production systems). This trend is highly strategic for the economy, because with the development of the Web, the volume of demand and its diversity has led to an extension of what is called "mass customization". The ability to customize a product is perceived as a real added value by consumers (knowing that customization starts with small batches models, then followed by personalized models and ends with personified models). The added value, as used here, allows manufacturers to maintain production at a given location by using higher selling prices.

Within this framework, we can give three examples:

– In finance, the automotive world, or in the wine business (which is non-ethical when considered to be macho), women have an increasingly important role to play: they are the ones who buy more and more products and thus their influence becomes predominant in the buying.

– Young generations are increasingly participating in the business of fashion and are expressing their needs before making purchases. Whatever the products considered: MIDs, the use of online applications, the production of wines that are less rich in sugar, or the consumption of alcohol (especially whiskey, whose fashion emerged in France after the Second World War), the evolution of new tastes and desires has an impact on the whole of the society. The NBIC can help here.

– Social innovation [MAS 13] allows for the emergence of very diversified and new needs that will have to be produced in large quantities and delivered to many users throughout the world.

This makes it possible to recall the curve of evolution of the systems of production, in the western world, from the beginning of the 20th Century up to the Industry 4.0 (Figure 1.1).

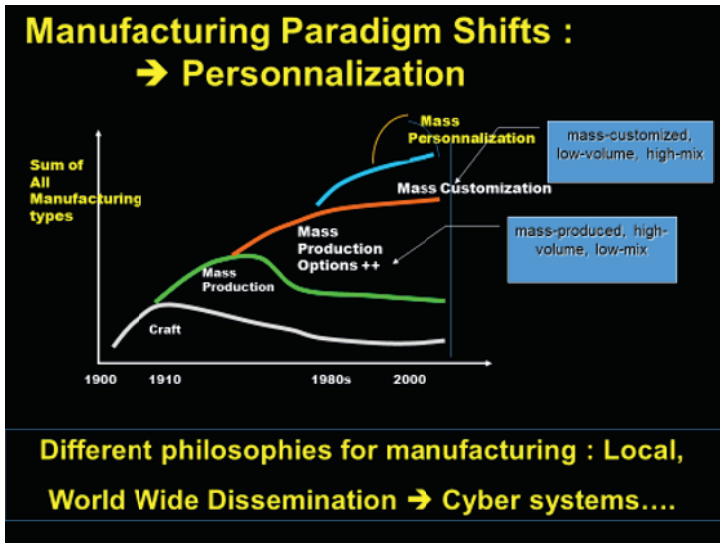

Figure 1.1. *Production systems' evolution toward personalization (4.0) and personification (5.0)*

As the ins and outs of mass personalization have recently become known and assimilated in our society, through Industry 4.0 concepts, we must look at another less known and new phenomenon: that of "personification".

1.4.3. *Toward personification*

With the development of big data, the growing importance of the notion of the "customer" through social networking, the economy is changing again: every individual and every Internet user is a potential customer who make or break the development of a brand or company. Its importance is vital because the Internet user is no longer simply a receptive consumer but also an "actor": he does not only consume or use a product or service, he makes the product, makes the mark, makes the reputation and the success of a company; he becomes an economic and social creator, a key stakeholder.

To satisfy him, it will not only be necessary to be emotionally attractive (it is not only the price that is considered) but also to create astonishment and to establish interactive dialogues (to enrich oneself with the knowledge and experience of other people, to exchange impressions, feelings, emotions, etc.). We are entering a psychological (it is partly what is done with organic

wine, but more than this is the biodynamics that represents the ultimate concept). In addition to a real need, we must be able to respond to concerns and build relationships based on trust. Thus, "thinking Client" is not enough; it is also necessary to "think Global Self" [GOL 04] which is composed of four complementary states: physical, psychological, spiritual and social.

Sensory marketing is no longer sufficient: we must consider here what is called "experiential marketing". This is when the client is perceived in his or her singularity, like anyone else, and that he will be opened to the company and will be given the possibility to install relations of trust. The client is an actor, the company is receptive (the roles are reversed). For the producer, this means listening, empathizing, sharing, and so on: the company has to provide the client with a personalized product or service, not only sensorially, but emotionally and psychically. As such, the terms "personalized" has been replaced by "personified".

This leads us to introduce a new curve that emerges from social networks and is called "personification". According to what has just been said, it is not a strategy of demand, but a strategy of supply: we have to decode its hidden desires and intentions (BDI model [MAS 15b]) and provide the client with something that will transcend them and make them live a unique experience.

DEFINITION.– Personification is a figure of style, in which the process of elaborating a model, a product or a service makes it possible to attribute to it human properties or characteristics peculiar to an individual (qualities, ideas, mental images, desires, thoughts, etc.). We thus obtain the model of a living organism or an inanimate object (concrete object, abstraction or concept) that can be identified itself with its user, its profile, corresponding to his deep needs, whether physical, psychological or spiritual. Much more than for an integration or assimilation, one can speak of incarnation or fusion of a solution in the user's deep "self". In the same way, we will not speak of "pleasure", but of "happiness" because the aim of personification is to possess a "personality", in order to be able to delight the person to whom it is addressed, or to satisfy one of his dreams.

At present, many new practices can be considered as similar to experiential marketing: a luxury car, a perfume, a personalized and caring welcome, listening to people, respecting, sharing emotions, visiting his house with friends, etc., help value a relationship and satisfy the "deep self" from our partner or "human client". They can be simple objects or luxury

goods … that are priceless: thus, experiential marketing can be defined as a set of devices and actions aimed at making the experience more or less memorable to the whole, or memorable and storable to any customer or prospects.

This will be the sixth possible curve in the above chart. It will be called "mass personification" and will characterize and integrate some concepts of the Industry 5.0 generation.

NOTE.– *In the industry, in large-scale retailers or department stores, where the policy is to supply products through online platforms (now with "drive" and "e-commerce" system), often at low costs, we are in an "on-demand" policy, and retailers or providers try to keep up with customer expectations, under the increasing pressure of competition. The world of wine (through its approach of "terroir", the stakes of wine tourism, the discovery of the "true" winegrower life, who is also a protector of nature, etc.) has succeeded in making its production unique and in developing its activity through the "on-supply" policy. Product marketing, as seen on television, aims to share a passion, tastes, flavors, lifestyles, experiences. The objective is not only to sell wine, shoes or skateboards… we also want to sell values, culture, travel and a heritage. By endowing products and services with some "personality", one escapes competitive pressure. The philosophy and aims related to commercial exchanges are becoming completely different. Business ethics will also have to integrate new economic patterns, orders and concerns*.

However, as with luxury goods, the supply must remain limited. The winegrower can spend only a short time with an individual: a meeting is a privilege limited on time. We will buy a luxury car not yet available or a limited edition luxury watch via the Internet, sometimes with high delays, just because we are trusting in the "brand". Here, the psychological aspects are more important than it seems: the pleasure, the satisfaction and the disappointments are measured in proportion to the initial motivations. Thus, a high-performance host will be followed by returns of rave reviews and thanks, among others, to the big data; however, it is a weapon that can also turn against the provider and cause a bitter disappointment: indeed, the more one desires something psychologically, the more one takes unforeseen risk.

Beyond mass personalization, rarity, luxury and the "personal" perception of happiness are characteristics that we are seeking more than ever before. We will find them in new production systems, in the ways of making wine, products of exception, and when we will spend time to discover and share experiences with individuals. We are no longer just thinking in a materialistic way. The concept of mind (behind a product) obliges us to integrate notions related to those of happiness, namely: hedonism and eudemonism. Ethics therefore has a new role to play.

What about ethics? The question of personality arises for the objects and software that surround us. Indeed, in order to generate, or not, an action or decision according to our consciousness, it is important that the products and services offered are in harmony with our own awareness or perception of the situation.

At present, very few of them, despite the progresses made in natural language, are endowed with personality: the modes of interaction that they have with us are likely to arise with increasing acuteness because they may have an influence on user behavior. For example: should a sports training program be kind to us? How can we stimulate our emulation? In cognitive robotics, a "personal support" software must be able to generate confidence to better answer the questions asked. The recommendations of decision-making tools need to be taken into consideration so that decision-making proposals are taken into account, etc. They must therefore be designed to answer the user according to his or her expectations and in a way that best suits him or her (respect for the personality of the person).

1.5. Emergence of nanotechnologies

Here, we are considering a multidisciplinary area involving and combining various fields of sciences such as: biology, medicine, chemistry, information systems, materials structure, but also nanoelectronics and nanomechanics.

1.5.1. *Characteristics of nanotechnologies*

When talking about nanotechnologies, people think about the miniaturization of the components associated with low energy consumption. However, nanotechnologies provide unexpected and greater improvements

in various areas (thin, lighter or less polluting packaging). For instance, in the agro-food industry, products can be richer in aromas and flavors; to preserve their properties, nanotechnologies can be used to develop containers with different structures and characteristics; then, by a specific maturing process, they can improve the quality of the foods, making them tastier, healthier and also more nourishing, etc. This is one positive aspect of nanotechnologies. At the level of ethics, nanotechnologies applied to food and drink can cause unforeseen and surprising effects. This involves taking care of potential risks to public health and the environment and to refrain from promoting them if a slightest doubt subsists.

1.5.2. *A paradigm change*

To go further, let us consider a phytosanitary procedure carried out with a chemical product packaged in pulverulent form. The use of nanotechnologies results in a physical change of existing products or processes that will have an effect on health. This particularity is also encountered in the field of fractals. Indeed, very fragmented products always have a larger contact area than observed on aggregated volumes (at a higher metric scale). Thus, the relationships and interactions between nanoparticles (or nanorobots) and neighboring products are always greater. At the nanometer scale, a nanoparticle will have a greater effect which will result in a different behavior of the whole.

To understand this phenomenon, two different packings will be hereafter considered for powders or oenological processing products. The packaging will consist of either micro or nano particles and will have different structures, to which we associate a smooth or rough form:

1) Case study of smooth forms/shapes:

Nature, which is using, better than man, the notions of morphogenesis, optimal forms and optimal convergences, has succeeded in generating optimal forms during its evolution and by successive trial and error: therefore, the overall shape (envelope) of a cell or a tissue, which receives its nutrients through its external surface, is optimized at the S/V ratio (external surface S vs. their internal volume V).

In the case of blood, for example, erythrocytes, or red globules of blood, are optimized to transport and exchange respiratory gases (O_2, CO_2), or to regulate the acidity of the medium (Ph). These cells have a "smooth" geometric shape whose envelope (like a crushed galette or flattened ball) requires a minimal plasma membrane energy for a maximum volume (content). This energy level is subject to the Willmore conjecture (recently demonstrated). It is this kind of microcomponent that we can mimic to develop particles for improving the treatment of some diseases or to build more suitable containers for logistics.

The transposition is quite simple to understand: our body holds a few liters of blood needed to ensure a part of our internal logistics. It must optimize its architecture, shapes and volumes to limit energy losses, save resources or reduce entropy: it will therefore draw its inspiration from the proven approaches existing in nature.

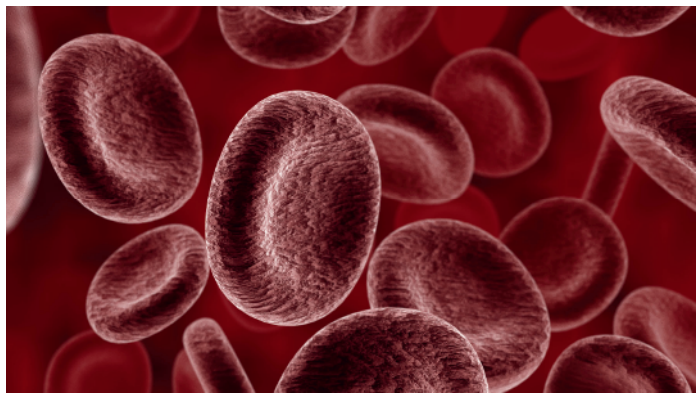

Figure 1.2. *Shape and pattern organization of red blood cells*

2) Case study of coarse surfaces:

The typical forms are those of the 3D fractals resulting, by extension, from the works of Benoit Mandelbrot: they are obtained by iteration, starting from an often simple nonlinear mathematical form, called 3D Mandelbulbs or Mandelboxes [LEY 10]. Mandelbulbs constitute a new class of fractal particles whose outer surface is very rough, simple, but the dimension of which is between 2D and 3D. This means that it is neither a surface nor a volume and that the contacts or interactions with the environment are very important. Such an effect, providing an advantage at the microlevel, will be

accentuated at the nanolevel and could even become harmful! It is in this sense that the nanoparticles resulting from the fragmentation of a larger body or generated by percolation or aggregation phenomena are a major innovation whose properties must be studied in order to increase their effects. This will be useful in developing new types of organizations and new management structures in the industry. Thus, we have to again target our actions on the future Industry 5.0.

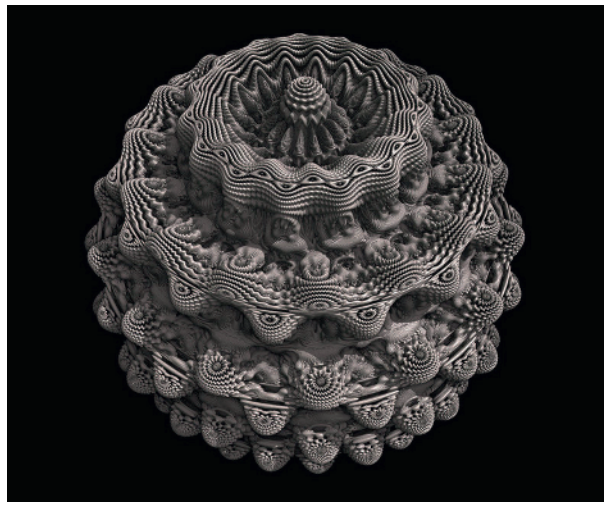

Figure 1.3. *Example of a 3D Mandelbulb structure*

1.5.3. *Perspectives, prospective and comments*

Possible nanotechnology applications are very promising, in the sense that it is possible to develop new opportunities in terms of products, medicines, transportation, etc.

With nanoparticles, many unexpected and unpredictable effects can be obtained to date, because different and more efficient actions (different interactions) can be performed on the molecules and constituents in a given environment. Similarly, a nanoparticle may more easily have a more "targeted" effect on a DNA molecule, hence on the generation of a specific protein or hormone. The same reasoning can be used for collaborative work implying large team structures and individuals. Also, same situation appears in spatial exploration, when scientists are working on the development of

nanosatellites that are being working, in a collaborative way, with large space stations or big satellites.

With nanorobots (swarmbots, when we are faced with the coordination of multirobot systems which consist of large numbers of mostly simple physical robots), it is possible to introduce artifacts (also called artilects) that will be able to carry out control functions, biological or agrochemical (local or global) having a greater impact on the evolution of the product: e.g. a car (and associated performance criteria), wine (or its organoleptic properties), etc.

Here we reach the limits of our understanding since we are now making the link between the living world and so-called "inert" matter (but here again one can say that a quark is inert while it is only one component of a more elaborated or complex assembly, to which we can give one attribute: the notion of "living").

NOTE.– This is new for ethics since its field of application is not only limited to living beings but must cover any element: from matter up to spirituality.

1.5.4. *Questions of ethics: a new way of thinking*

We must first remember that in uncertain and complex situations, the predictability of an event or a situation is impossible. This is the reason why we cannot anticipate facts and why a solution consists of being reactive [MAS 15b]. On the other hand, if it is not possible to anticipate a specific fact and the probable date at which it can manifest itself (scheduling), it is possible to identify what events could occur in order to prepare the possible actions plans (reactions, feedbacks or counter-actions) in a given context.

The challenge of ethics today: "the most difficult in this disturbed period is not to do one's duty but to know it." Indeed, knowledge of the ins and outs of an action and its interactions within a complex system are much more valuable knowledge. This avoids blocking solutions, bottlenecks, and thus the possibility for the populations, who have an urgent need, to benefit from the progresses of the innovation.

According to Edgar Morin, in a world where we cannot foresee the future (and this is the case for any innovation whose effects are unknown), duty needs for some knowledge: indeed, doing one's duty is not easy, but it is uncertain and random. Hence, the need for a global ethics… combining thought of ethics and ethics of thought.

Therefore, taking medicine as an example, we can formulate a comment on the R&D: rather than looking for a more effective molecule, it is more important to research how to organize and implement the treatment of sick people; by working on the structure of the excipients and the support types of the active ingredients (fractal fragmentation or fractal aggregation), it is possible to improve the quality and performance of the treatments … while being as less harmful as possible (since we are focusing on the process and not on the product). It is often that way, the most effective and efficient innovations are developed in the industry.

The whole issue of the "thought re-engineering" as recommended by Edgar Morin [MOR 04] is to allow for a better sharing of knowledge, necessary to improve human understanding:

> "The fundamental cause of misunderstanding is also associated with: errors (so common in human communication), indifference, incomprehension from culture to culture, possession by gods, myths, ideas, selfishness and self-centeredness, abstraction, blindness, and finally fear or refusal to understand. Faced with all these obstacles, we must carry out a work of understanding based on complex thought in order to reach a meta-point of view. However, 'working to think better and well' is not always enough to overcome misunderstanding: "the one who understands is fully dissymmetrical with one who cannot, or does not want, to understand".

1.6. Development of biotechnologies

These approaches are booming and will complement, or accentuate or replace technologies already used either in agro-chemistry or in other sectors of the economy. At first glance, in agriculture, producers are interested in the numerous research and development activities carried out at INRA [INR 13]: their R&D is dedicated to the improvement of process performance in order to meet specific sustainability needs.

Now, thanks to the progress of processes like genome sequencing, it becomes possible to go much further (disruptive change), with the ability to "cut and paste" DNA which leads to plant organisms or other living species, that is to say to modify certain sequences. As a result, the objective is to

erase or correct a defect, or, conversely, to accentuate a given characteristic that will ultimately be found in the final modified product. As certain variants of our genes are a factor of risk for various diseases (such as cancers or cardiovascular diseases), it will therefore be possible to amplify the production of some specific genes (by mutation to inactivate them) in order to make us more resistant to disease, or allowing cell receptors to avoid invasion as well as replication or survival of specific viruses.

These actions and modifications in the genome, then in the expression of genes or specific proteins, have a double characteristic that affects the notion of transhumanism: in this case, it is not only a question of repairing or correcting a defect that penalizes us (the first characteristics), but to bring something more, that is to say, a specific improvement, a new function like the sensory sensation or a new capacity at the level of our body. When applying any new technology, the problem is the same: what do we mean by consumed product? What do we mean by "something more"? If it is "something less": what kind of impact will we have at humankind level? Is it ethically acceptable?

Genetic manipulation is inevitable, because it corresponds to human beings' demand (in terms of human species progress): every day, for our food, our health, our way of life, we use genetically modified organisms (GMOs). We cannot go backwards: the evolution of humanity is such that everything happens in front of us and not behind us (hence the attenuation, in time, of the memory effects that is specific to nature: once made, the selection of a learned fact, this one will be integrated in the genes). Indeed, at the level of living species, there are two properties: the "acquired" and the "innate". In the case of adaptation of an organism or living species to a disturbance, that is followed by an improvement, mutation or evolution, the result(s) of this adaptation phenomena (the "acquired") are progressively integrated into the genetic asset of the species (i.e. the "innate").

What about ethics? Within this framework, it is important to set up safeguards or precautions, i.e. create ways to mitigate the carelessness of human beings. However, we have to trust Mother Nature: the risk of deviance remains low because nature is endowed with self-organization principles: in case of an inappropriate situation, it will activate mechanisms of self-adaptation (as is already done in the DNA, to ensure the resilience of information). It has been like this for billions of years, and has achieved one

remarkable result: the human species. However, in nature, humankind is only one of its avatars and it is able to keep us check and control us.

What is written here is not shocking as nearly 80% of the food consumed is derived from these practices, as 90% of the current products we use contain components derived from biotechnology, and as hybrid technologies will be soon present in all the sectors of our economy.

1.7. 3D printing and the future of manufacturing

1.7.1. *Impacts of innovation*

Generally speaking, the question is to know what the future will be, in an organization, after the introduction of an innovation or a new technology.

3D printing is part of the so-called "additive manufacturing"; it is a promising technique, and its near-term expectations are maybe overoptimistic. 3D printing was developed in the 1980s and is today a way to drastically improve efficiency and reduce production costs, mainly for manufacturing complex physical components.

Here, we can display an image that overlaid Rogers's Diffusion of Innovations curve on top of Gartner's Hype Curve [TEM 14]: we have to be careful, because after an over-expectation, there are always disillusionments, which follow after a given time period of maturation, adaptation and integration, by an acceptance and exploitation of the innovation.

Figure 1.4. *Acceptation curve of innovation development and usage*

Most important, however, is to see what kind of improvement we can get. Here, we will refer to an excellent paper published by James Bon Tempo [TEM 15].

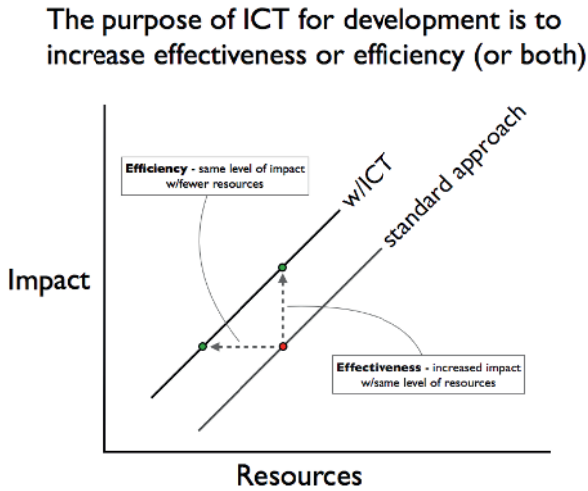

Figure 1.5. *Competitivity impact of a new approach [TEM 15]*

This graph illustrates how a process can be improved thanks to the integration of a new technology: as we can see, it is a question of productivity, quality and performance. Tangibly, and overtime, the improvements will be of three kinds: creation of values (and richness), creation of activity and creation of employment. In terms of ethics and sustainability, this is what we have to keep in mind.

1.7.2. *Some applications of 3D printing*

3D printing makes it possible to manufacture a 3D physical object (a complex component) from a computer file containing the technical specifications of the object under consideration. It is possible to control an extruder and to superimpose thousands of layers of thermoplastic material (rubber, plastic, sugar, clay, paste, metallic resins, etc.) in order to ultimately obtain a complexly shaped part. For instance, General Electric (GE) has produced new printed nozzle for jet engines and reduced the need for expensive materials and energy; same examples are quoted in the car industry.

This “additive manufacturing” technique can be used in many domains such as aviation, biomedical engineering, the automotive industry and the food industry; even metalworking industries are likely to be the earliest adopters of additive manufacturing. These applications have helped scientists to gain a deeper understanding of development, of certification practices and of how past experiences with composite materials or powder metallurgy might affect the sustainability of the manufacturing processes evolving toward additive manufacturing.

This relatively recent technology is also the subject of new “open” developments: for example, in the early days of its existence, MakerBot succeeded in uniting a whole community united around the values of sharing due to so-called “Ethical Innovation”, and against “hacker-type” behaviors. This company also opened the “Thingiverse” site where designers from around the world can take advantage and share with others the plans of objects and their characteristics that they have specified, prototyped as part of their 3D activities (with low end extruder-type 3D printing systems). This notion of sharing is very important and raises ethical problems that we discussed in Chapter 5 (misuses and whistleblowing).

3D printing is not limited to plastic and metal. In the field of health, surgery (prostheses), biology, or even transhumanism, we can now manufacture, with a printer, human tissue. In the near future, it will be possible to rebuild whole organs or parts of skin for living species: there will be no limit for bioprinting. Except for those imposed by ethics: indeed, we know that the notion of bioethics and transhumanism are subjects of important discussions.

We can quote some examples in pharmaceutical research: the Californian company Organovo has promised by the end of 2017 to supply liver tissue for therapeutic trials. Moreover, in Princetown University, a “bionic ear” was printed using a biological inkjet printer [WIL 14].

Similarly, in the food industry, culinary or food printing has evolved with this technology; many foods which are soft at ambient temperature are already printable: a raw material (e.g. chocolate, flour, sugar or even meat) is powdered, then mixed with a binder (gel), then medical components

or biological nanoparticles are added (to get "alicaments"), and finally, spices or perfumes are introduced. Hence, after kneading, we obtain a paste.

This approach could be the future of a mass food supply, within the Industry 4.0 framework. It is justified by the fact that soon we will be more than 10 trillion people on the planet, and that the majority of people are urbanized and do not know the significance of real and true food. Therefore, our society is ready for the industrial personalization of the food, downstream, in order to adapt it to various needs:

– By measuring the right proportions of raw materials and inputs in the process of preparing the cooked dish, it is possible to produce products that meet specific caloric needs, including medical therapies, with precise taste properties, and so on.

– With a specific molding machine, … and based on the accuracy of 3D printers, it becomes possible to manufacture foods, perfectly balanced with nutritional intake, perfectly controlled and adapted to each category of particular individuals such as sportsmen (for their muscles), politicians (who require more phosphorus to issue more pertinent decisions), or people with digestive, physical or biomechanical problems, and at last festive youth, etc.

– For babies or the elderly, this approach makes it possible to create balanced, healthy, tasty, and easy-to-swallow food (seniors, also, often have problems with chewing or swallowing …).

1.7.3. *Basic questions of ethics*

With robotics, 3D printing and AI, this is the era of tube feeding cosmonauts, and the one of urbanized citizens!

We cannot predict today, within our Western culture, whether it is the right or the wrong solution, that is to say, if this evolution is "good" and marked with justice. Only the future will tell. In terms of ethics, this is an ethical choice between "quality of life", "culinary and cultural heritage", "lifespan" and sustainability. Our personal consciousness is certainly important, but it cannot ignore the others (the 1.5 billion people who are hungry) and the general interest of the natural world.

Again, in terms of ethics and morals, some researchers and executives of large companies are expressing some concerns about the quality of new artifacts, organs and real/or virtual products; how to use them and how to control their production.

Without precise and complete regulations, ethics is essential to know where, how far and how to go. Indeed, with 3D printing, AI and robotics, we blur the lines between man and machine, between humanists and materialists. Albert Einstein's most famous quote is, "God does not play dice with the universe". However, now, humankind has decided to "play God" or super sorcerers on a scale that we do not know how to evaluate.

1.7.4. *How to fulfill ethics with 3D printing?*

Since the antikythera machine, more than 2,000 years ago, a lot of ethical progresses have been carried out and applied to our society. It is however interesting to highlight another advance called 3D printing.

The United Nations Office for Disaster Risk Reduction (UNISDR) calculated that several billion people have been affected by disasters between 2000 and 2012. According to UNISDR, more than 1.2 million people were killed and $2 trillion were sustained in damages.

Unfortunately, recovery from disaster is costly. In the aftermath of floods, earthquakes, conflict and other emergencies, access to basic items needed for survival can be severely limited and expensive, and, due to the violent nature of these disasters, it may also be necessary to provide injured people with prosthetic devices (e.g. artificial hands).

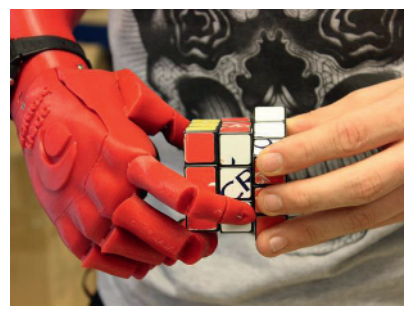

Figure 1.6. *How 3D printing can help to compensate physical handicap*

These things are all necessary in order, to resolve logistics problems and to continue living or working. Indeed, simple items can mean the difference between life and death. “A bucket, for instance, essential for health and hygiene, may only cost a few dollars in a capital city but supply chains and support costs mean that in reality, this simple item is expensive and can take weeks or even months to arrive in the hands of disaster victims”.

For instance, for mechanical repairs, one needs to have access to specific tools. As procurement in damaged countries is difficult; 3D printing may solve such a problem.

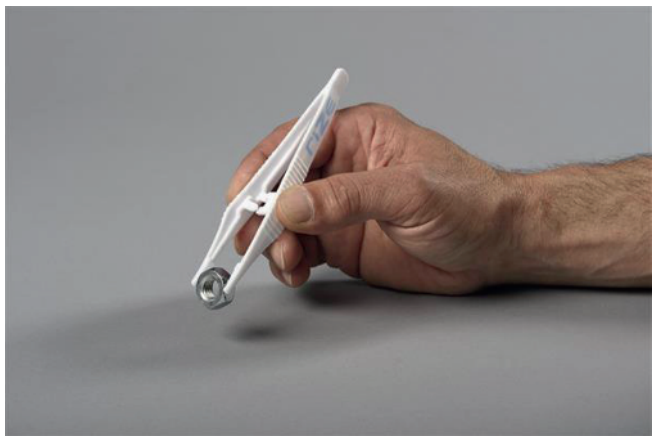

Figure 1.7. *3D printing can provide emergency equipment in the aftermath of natural disasters, for example (source: https://borgenproject.org/field-ready-uses-3d-printing-create-disaster-relief-supplies/)*

This technology may also be used for rebuilding, in emergency, some maintenance parts and then to repair and re-use a strategic equipment to be used in disasters.

For example, following the 2010 earthquake that devastated Haïti, Field Ready (an NGP organization) worked with other relief organizations to print products like mosquito-net closures and tools for aid workers, TB patients, newborn babies and maternity patients. The organization’s efforts established safer patient areas and workspaces, as well as reduced the risk of mosquito-borne diseases.

Figure 1.8. *The Field Ready logo*

During their first stay in Haiti, Field Ready's members were especially struck by the shortage of maternal health equipment. Although nurses and doctors could sometimes improvise makeshift tools such as clamps for newborn children's umbilical cords, Field Ready sought a better solution: they were able to print clamps on 3D printing presses, reducing the risk of neonatal umbilical sepsis. They also trained Haitian staff to use 3D presses to ensure that they would have a permanent alternative to importing costly equipment from more developed areas at additional expense.

In terms of ethics, 3D printing is a fully ethical solution that enables to help in the recovery of difficult situations.

1.8. The future: wedding of transdisciplinary technologies

Complexity requires the merging of advanced technologies such as: biotechnologies, nanotechnologies, network theory and mathematics. But let us go back to kitchening!

The transposition of new paradigms is the logical continuation of what is done with molecular cuisine. Everything has to be recreated each time to involve tiny processes. For example, consuming a "sabaillon" or chocolate mousse, with a specific taste, is not done in a steady way: everything is a matter of contact surface, temperature and oxidation: if one works with whole or raw fruits and vegetables, micronized emulsions or nanoparticles (not to mention cooking or aging), we will get different results. Moreover, everything depends on the nearest gram, to the nearest second, to the nearest

handling (the know-how). In terms of probability and only in this example: just by varying infinitesimally the value of each parameter, more or less, and considering an assembly of three or four different products, we already have several thousand different results! One can easily obtain a multitude of different products, different perceptions … not to mention the organoleptic nuances, which vary infinitely given the problems of interactions: everything becomes sensitive to infinitesimal variations, everything can become chaotic [MAS 17a].

Moreover, with the new technologies that have just emerged and that are not yet precisely controlled, how can we envisage and control such processes?

Not only is the world complex (unpredictable), it is also uncertain (because of lack of control); in other words, we are going to be confronted with phenomena of emergence and convergence: complexity is such that we have unpredictable effects. What is known is that, in deterministic chaos, the parameters evolve in an unpredictable way within certain constraints (geometric envelopes). We thus find great tendencies peculiar to a given product, since we are bounded; but in terms of the fineness and accuracy of a result, a perception, a sensory or physiological effect, we will have a very great variability. It can be compared to quantum physics, with the uncertainties of the valence bands.

However nature, with its self-organizing and self-adaptive capacities, has shown us that everything is for the best in the best of all worlds. This facilitates the ethical judgment that one can have: when faced with a difficult decision, we must not reject what technical progress can bring us. Thus, the best way to adapt is to be trained and experienced with the new technologies.

1.9. New opportunities: precision and sustainability

From the notions of personalization, we discussed those concerning the personification. Behind these modes of production and transformation, made possible by nanotechnologies and biotechnologies, we will be able to

integrate new innovations. Before going any further, we will focus our attention on three words, or concepts: which will allow the reader to better understand the rest of the contents of the chapter. Those are:

– precision;

– outsourcing;

– internalization (not internationalization).

We will clarify these terms and see how ethics can intervene in these contexts. In order to do this, we will draw on one example of everyday life, linked to the sustainability of systems and transhumanism. This example is from the field of agriculture: the concept of "precision agriculture", described because it is important to understand the current actions being taken against pollution (related to various discharges, bio-waste or packaging).

1.9.1. *Bio-wasting [CYR 15]*

In recent years, an emphasis has been placed on the concepts of sustainable development. The word "sustainable" has a connotation close to that of resilience (which is one of its components). However, in the following, we will only talk about "sustainability".

The COP21 conference dealt with pollution-related issues associated with global warming. Irrespective of the results obtained, a greater awareness has been raised and some actions and decrees have been put in place, and regardless of the debates, progress is being continuously carried out. For instance, in the field of wine making, tools for the treatment of effluents are increasingly used. Similarly, retention and settling basins are being built near winemaking cellars: a winegrower, beyond a certain amount of effluents, must bring them to a processing center, etc.

A clear regulation has been defined: decree no. 2011-828 from 11 July 2011 defines the provisions on waste prevention and management: it stipulates that any producer (holder) of a large quantity of bio-waste (waste is composed of organic matter that can be biologically recovered, either by composting or by methanation) has to ensure that they are sorted at source for recovery. Thresholds have been set for each effluent; when somebody produces or holds bio-waste at several sites, the threshold is assessed

according to the total quantities held on each production site. The processing and recovery of bio-waste may be carried out directly by the producer or entrusted to a third party after transportation.

This is a very recent process: 50 years ago, during the huge development of chemical treatments (economy of war), no one really asked questions about the toxicity of the products. When I was a young boy, I remember a winegrower who died as a result of treatment based on sodium arsenite (Pyralesca). He was injured during the treatment and was poisoned. In terms of ethics, this type of chemical has been outlawed since the 2000s: in this case, the notion of health has prevailed over that of economy. On the other hand, in terms of behavior, we are torn between the notions of victim and responsible: we cannot blame a person who does not know! Similarly, on an economic and psychological level, the ethical approach must not be mediated and must remain rational: the optimization of the protective process and the preservation of the ecosystem first consists of reducing the quantities of toxins and hazardous wastes, then in pre-processing wastes.

1.9.2. *Importance of the precision process*

Wine processing is a complicated process, in the sense that one must achieve something complex, at best, with limited resources and limited capacities, taking into account a certain number of constraints. This is summarized in the image below [MAS 17b].

Figure 1.9. *Sustainability challenges*

NOTE.– Comments about constraints and the resulting risk management:

– Information processing is not easy: it is diversified, unstructured and non-monotonous (in the sense that they vary continuously and dynamically).

– Minimization of inputs (water, energy, raw materials, etc.) and pollutants, overproduction, stocks and inventories, etc.

– Global optimization because the process concerns the ecosystem in its totality, and we have to ensure the sustainability of the system.

– Risk management is permanent because the world is unknown, uncertain, fuzzy and complex, and therefore not predictable.

Given all this information, it is clearly impossible to model an overall system in a small amount of time and to then solve it optimally. As is said in decision theory, the difficulty is such that it is increasingly desirable to find a "well-balanced" response in the short-term, rather than the optimal response over a long period of time. In fact, what we are going to look for is the best possible equilibria (as done in game theory, auction or Nash theory).

1.9.2.1. *Generalization*

When we speak of equilibriums, we come to consider that life is made up of consensus and equilibria between ambivalences (as we know: in nature, everything is ambivalent, dialogic; each character, each property possesses an antagonistic element, an anti-symmetry, an antonym, etc.). To be fully rational: one would use regenerative approaches or algorithms based on game theory. But, fortunately, human beings naturally rely on their instinct, their intuition, their art of living, their ethics, … and perhaps this is better: if we observe the winegrower elaborating his wine, each wine is an exception, a work of art, elaborated according to its own sensibility and consciousness; a winemaker can be proud of what he creates day after day… It is the same feeling for a craftsman, an artist, a professional in an industry!

1.9.2.2. *Precision manufacturing*

Managers need to think about precision when in charge of organizing and operating a production unit. They do what is necessary to produce the best result, to pollute and to reject pollutants as little as possible, to bring maximum happiness, and to respect the environment as much as possible.

In our everyday work, in the factory, in the office, or in the fields, ethics is a simple thing, often based on the awareness of what is right, good, noble, virtuous and respectful: some call it love.

At a time when politicians are proposing a same pay (salary) or subsidies (for materialist and reprehensible purposes) in the name of equality or in the face of adversity…, we can see how the notion of justice and equality (included in ethics) is devalued. Equality is good when it is conforming with equity. Within the context of evolution of a civilization, it is expected to ask ourselves some questions, then to go and see what happened into Eden and Greek ancient history!

1.9.3. *Application: oenology of "precision" and the sustainability*

Precision in agriculture: without mentioning optimization throughout the PLM, the concept of "precision oenology" or "precision agriculture" requires first to formalize, specify, record any task or information, at each stage of the wine process, along the product lifecycle management (PLM), in order to identify and target the needs. This is done, for example, in association with the HACCP approach. It involves identifying not only new methods of work, but also everything related to control of tasks: oxidation phenomena, control of all the determinants of the quality of wines (for example, precursors of flavorings, polyphenols, compounds produced during winemaking or during the assembly and rearing), in order to control efforts, inputs, costs, wastes and scraps.

What is advocated here is already done successfully in the industry: when one moves forward in the unknown, when one changes paradigm, or when one introduces new technologies, the fact of describing a problem, formalizing it and modeling it allows us to solve it to 50%. With a methodology and common sense, economic gains are already significant.

Finally, the concept of precision in oenology, which is superimposed on the existing one, integrates eco-design approaches, societal, economic and human concerns that make it an integral part of sustainability: indeed, we will adjust at their best the parameters on the whole value-added chain. To optimize a "local" process, it is necessary to integrate a "global", systemic or holonic approach, which means that ethics is a "global" notion of business conduct.

This is far from uncontrolled or non-controllable expenditures, corruption and inefficient regulations: the first problem, which is discussed in all discussions, is not the introduction of digital technology, technological innovation, process automation (it will be pushed with the use of sensors and actuators), but changes in thinking, rigor, methodological approach, ethics, etc. The remaining, such as economies and sustainability, will come on their own.

1.10. The current digitization strategy

Nanotechnologies and biotechnologies have enabled a lot of advances, as discussed earlier: but it is just the beginning. Now we will address all the new technologies based on the data, information and knowledge technologies, and the so-called digitization strategy.

The question now is to know at what level of paradigm shift our businesses lie. What are the advances that we want to implement? For what purpose? What is our level of digitalization?

The reference document of the European Union, "Digital Manufacturing – version 2013", recalls what is meant by "4.0 Manufacturing", namely: "the implementation of a flexible production system, competitive (efficient), responsive, economical and more sustainable (through its management of human and natural resources and environmental resilience), which will be achieved through better automation, robotization and integration of the full Added Value Chain".

When it comes to innovation in France, and when it is announced that a company in the agro-food industry (AFI) has developed a new sensor, an improvement in a product or a new control system, this is interesting because we are improving the performance of our wine sector. We must keep in mind, however, that it is everyone in Europe, if not in the world, who does the same!

Our competitiveness certainly improves, but that of others (our competitors) improves as well. If our normative or legal system does not evolve, we remain behind, in a precarious situation. Alain Marty has depicted this situation very well in his book [MAR 04]. It is therefore urgent on behalf of the "social democracy" to know how European funds are used, for what purposes and with what concrete results. It is a simple problem of ROI (return on investment), and it is our responsibility and not that of

Europe to check the validity and the equality of the different contributions all the more because we have elected officials within this framework.

According to Brussels, everything is supposed to progress in a continuous and evolutionary way, knowing that everything is interconnected. The term "everything" is important: today we have a global way of thinking focused on IOT (the Internet of Things). For example, when a winemaking control device is monitored from an application located in a smartphone. On the other hand, in some countries, we have switched from "everything" to "anything": then people use the more global notion of IOE (Internet of Everything). In this context, it is a question of connecting an olfactory sensor with an intestinal controller/robot, to interact with two other robots located in different wine tanks at a given wine producer. Automatically, it is a customized assembly, including different sensors and computers that are interconnected: it is then possible to provide a global service like a robot will set up a delicious dish, adapted to my taste and my diabetes, which will be delivered quickly in my house, with a drone. Meanwhile, another nanorobot will adjust my insulin level, prepare me physically for tasting, and psychically prepare me by displaying on my 3D helmet screen a movie with Julia Roberts, etc.

For those who would be ethically shocked, one can ask the following question: is it fiction? The answer is no because technologies are there, and every data is recorded, normalized, adjusted. We are constantly observed (the big brother effect), but we are delighted to "post" our information, images, personal photos, feelings, opinions, tastes and desires, etc. on the Internet: we need to show ourselves, to value ourselves, to be recognized, thus to live. Therefore, with our agreement, we are dissected, segmented, conditioned.

We no longer belong to ourselves, we belong to the big data. Human beings are the products of information (through the DNA and its program from which we are created). We are living in symbiosis with nature, with its elements; but everything we do, live and think is online: to make it simple, what we are generating is information and it is stored on the Internet. It is for this reason that the richness of the future, the added value to be exploited, is that information which is on the Web.

In summary, and without wanting to provoke, without re-launching a debate like COP21, we could say that nature has created man with information and that what we give back to nature, as an inheritance, is the information that we leave behind us.

Thus, we are receiving information, and we give back an augmented information. By disincarnating man, we see that we are only avatars of nature, objects in the broad sense of the term, hence the notion of IOE (Internet of Everything). We are therefore "integrated" into a digital loop.

On the other hand, it would be appropriate to ask, before drinking a glass of naturally sweet wine, what we want to do and have in the future: beyond ethics, happiness, comfort and life (why not?), what are we looking for?

1.11. Robotics, how and for which purpose?

In the field of robotics we can distinguish:

– conventional robotics, which everyone knows;

– soft robotics;

– cognitive robotics.

These three categories use artificial intelligence for their operational functioning.

1) By definition, *conventional robotics* is the branch of mechanical engineering, electrical engineering and computer science that deals with the design, construction and operation of robots (autonomous automatic machines) as well as systems. Computer systems are used for their control, sensory feedback and information processing. These technologies can work in relation with other automated machines, can take the place of humans in dangerous environments, or can imitate human beings in appearance and behavior, or perform difficult tasks faster, etc.

Similarly, robots could one day be able to replace organs in our body and carry out specific bodily functions in our place, thus alleviating some physical handicaps. Moreover, many of today's robots are inspired by nature, and by man, which gave birth to the concept of "bio-inspired" robotics.

2) Recently, *soft robotics* has been developed: this emerging field deals with "soft robots" (such as drones or molecular devices based on bio-components). They are built from flexible, elastic or deformable materials (silicone, plastic, rubbers, polymers, shape memory materials, DNA, etc.) or deformable mechanical parts (springs, elastics, gels, shock or vibrations absorbers).

Since the beginning of the 21st Century, this field of robotics has attracted increasing interest and has helped to reduce the price of certain robots and to improve the response times of conventional robotics to questions such as "self-repair", self-organization and cooperative adaptive systems, which is in the sense of sustainability.

3) Finally, there is *cognitive robotics*, based on computer programs (software for data processing, reasoning on information, and neural applications, etc.) which we will discuss below, since this latter subject deserves some development.

1.12. Cognitive sciences, cognitivism

Cognitivism is an important field endorsing the assumption that thought is a process of information processing. The notion of cognition is of key importance as it includes manipulation of symbols, deep learning capabilities and symbolic representations by a computer according to a set of rules. It enables disruptive changes in terms of artificial intelligence.

This section is the logical continuation of what has just been presented on the topic of robotics or "big data". When one thinks about cognitive engineering or cognitive informatics, one thinks of knowledge processing. A few years ago, I had the opportunity to question researchers in R&D laboratories: surprisingly, I found people who were still using spreadsheets (very conventional tools) to make decisions. I was very surprised. I drew a parallel with Japan, where some business leaders also used abacuses to determine which option or decision to choose, based on statistics collected through conventional approaches. We are far from elaborated processes in which we could perform what are called: weak signal extraction, inference, learning, reproducibility of results, or "multi-dimensional" processing of a problem.

On the other hand, many people talk about artificial intelligence, i.e. AI, as opposed to human intelligence. Here, AI specialists, like data scientists, distinguish two forms of AI: weak AI and strong AI. With regard to my own experience in IBM, we have in fact decided to consider three types of AI (related to three types of modeling processes).

1.12.1. *Weak artificial intelligence*

Weak artificial intelligence corresponds to the emulation of simple and repetitive human activities. In this case, a set of skills can be "programmed" and modeled. Here, robots are able to perform relatively simple reasoning or processing tasks. Currently, this type of application can be found in automatic control systems. There is no fear: to draw a parallel with the schooling of young people, one is at the level of: B - A - BA (basic course). The technological risks are still very low: robots are not yet at the bachelor or doctorate level. They only solve problems that they know how to model, such as the analysis or the control of deviations, defects or failures analysis, automatic operational procedures, etc.

These are often very profitable applications that can be directly implemented.

1.12.2. *Strong artificial intelligence*

Strong artificial intelligence corresponds to the ability to emulate higher human intelligence and thus integrate notions of self-awareness, emotions, love and hate, fear or suffering, etc. These robots are here able to perform more sophisticated functions, closer to those of humans. When integrated in a robot, strong AI is capable of giving autonomy; it makes it possible to make decisions, to learn, to correct one's mistakes alone, to reorganize oneself. These robots are at the bachelor level. Without the presence of a human, they eventually stop functioning. In order to understand where they are, we could say that they are at the level of the "augmented man". For example, if one has a disability, one does not only correct one function, but one increases it to make it more effective than the one naturally available to the human.

Similarly, when we are faced with a problem to be solved, we must find the right question for a problem or for a result that we seek. Here, we consider the IBM Watson machine: it is able to understand natural language, to make a semantic analysis of the context, to understand the meaning of the questioning, to cover the 200–500 million files (experiments), also called "Test Cases" which were at the origin of the CBR (case-based reasoning approach) and to do some inductive and, above all, abductive logic processing. As will be seen with serendipity, abduction is the best way to create, discover and find new knowledge, which can then be learned by a robot.

As we can see, these robots are not yet at the "virtual human beings" level, with "life" capacities such as: reproduction, complete autonomy, adaptation to ensure the sustainability of the whole.

They are not yet at the level of "true expertise". True expertise is associated with emotional and ethical reasoning. It also calls for anticipation and intuition. It is the highest level in AI. At IBM Manufacturing, we never tried to achieve this last goal: indeed, when implementing a new process with embedded AI functions, we were focusing on the human control of the application. Therefore, we did not need such elaborated functionalities. Organizationally and humanely speaking, we were not ready for implementing full autonomous features: the problems raised would have been critical. Now, we are just entering in the phase of transhumanism [FER 16].

So there is still room for the introduction of new technologies that could fully replace humans. Thus, beyond strong AI, there is what we could call universal AI, which would include this so-called true expertise. There is still room for improvement.

With strong AI, we are able to produce objects and services on demand, corresponding to our physiological, cultural and psycho-sensorial preferences, as we do with VOD (video on demand).

Going back to kitchen, we are certainly far from the recipes of our ancestors; we are in the productivist AFI (agro-food industry). Today, we know how to cook "artificial veal blanquette", to replace meat with vegetable, make artificial wines, and so on. We are not yet at the level of old wines and naturally sweet wines (the ultimate stage of oenology, art and culture!).

With the concept of universal AI, robots could replace our ancestral heritage, our activity and our very jobs. But what will we do? What will we do with our fingers crossed in the sun of South of France? At a time when ethics committees are being created to mediate whether the elderly can drink wine, we will have in the future good conscience by entrusting this task to hyper robots with a nice "Universal AI": they will decide, instead of us, the ability to do something or to continue living.

1.12.3. *False artificial intelligence*

This kind of AI lies between weak and false AI. It gives the impression of real expertise since from symptoms, robots can deduce directly what is wrong in the system under study. However, the reasoning is not profound, and if we are asked to explain how we can find a given result, the expert is able to detail the chaining among the production rules, to explain a procedure in a logical order, and to link the defect with the causes and the symptoms. In such a process, there is no abduction, no emotion, no intuition.

For this reason, we call this false AI (which fits with false expertise).

On the other hand, we would have to detail the "collective AI". We will not detail here, since it is a different concept based on swarmbots.

1.13. NBIC: innovation business models

1.13.1. *Vertical integration of the technological innovations*

Concerning recent processes of automation in the vineyard, there are real progresses in terms of performance, quality or sustainability: these are often automated equipment with sensors, associated with a programmable computer. This improves processes and enables many changes in the conventional practices. For example: tools to monitor the maturity of grapes and the acidity of musts; monitoring and control of tillage; automatic feeding of leaf strips to regulate the maturity of the grapes; automatic dosing system

during phytosanitary treatments; automatic sorting of the harvest; treatment of nitrogen deficiencies in the cellar, etc. These are local and not integrated innovations: but taken as a whole, they will improve the overall performance and quality of the wine.

By producing better grapes and selling better wines, the whole chain of value is improved. This is so-called vertical integration, and corresponds to a new type of business model. This is also the case in the car industry: autonomous vehicles (Fiat, Renault, GM, Ford, BMW, etc.) are based on standard sensors and components (more reliable) to improve the transportation system. The problem here is not to invent a new technology: it already exists. The problem is the "integration" of the information system within the context of the environment we are living in. Ultimately, stand-alone vehicles will be reliable and the vertical integration of technologies and activities will be possible.

1.13.2. *Horizontal integration of the technological innovations*

However, the real progress lies in the fact that many diverse and disparate data (from automated grape harvesting machines, wine making operations or bottling, etc.) can be collected and elevated to the "big data" level (centralized databases). These data will be analyzed in huge servers. However, it is in adjoining areas (for example, the sale of catering services or hotels, the sale of stays of stress treatment, etc.), to our database analysis strategy, that we will be able to realize the biggest revenues. Similarly, with some wine products, one could imagine developing activities in the field of health, luxury, or meet future needs/progress related to genetics, implement new properties of the physics of materials, Negentropia, plant and animal biology, etc. In any application field, we have to stay curious and open minded.

In car manufacturing, TESLA has the leadership in a specific field (electric batteries). Its goal is not to make energy storage, but to become the leader in an alternative mode of transport.

Another example: IBM is a leader in projects oriented to "cognitive science information". In order to gain a competitive advantage, IBM engineers are investing in paradigm shifts such as: quantum physics,

spintronics, molecular electronics, 4D printing (metamorphisms, etc.) all applied to the storage of data in agriculture, cognitive computing, etc.

Recently, Intel was challenged in the field of microprocessors for MID (mobile Internet devices). Indeed, PC activity was in decline, so they had positioned themselves within the niche of tablets and smartphones, etc. Now they are going toward IOE, data centers and big data (through its subsidiary Altera Cie and the 5G).

In all these cases, we are faced with metamorphic and adjacency problems: this means that companies are also devoted to horizontal integration! One is therefore in the unknown, in the serendipity: this one will be the object of a development in the next chapter.

With ethics, the approach must be the same: it is necessary to enlarge the scope of the studies and to take into account either vertical or horizontal integration. It is a full holonic approach that is required.

1.13.3. *Organization: the new business model*

What is first described in the field of wine is how the processes of wine making are organized. Currently, IT is used as a tool for productivity and communication in cellars, but also among large producers or markets. At the level of the wine business model, and remaining global, the two concepts to which we are oriented are:

– mass production for standard products;

– personification for already personalized productions.

In both the cases, but applied differently to the wine, the notion of particularization will be used either to adjust the treatments and cultivation practices or to limit as much as possible the inputs and the pollutants.

The remarkable thing with wine is that we have integrated (in our mind) some concepts and advances related to Industry 5.0, while in terms of implementation and ICT, we are starting with Industry 2.0 characteristics.

Indeed, digitization remains a poorly controlled technology in terms of use (except for the primary automation of some production tasks). This explains why, today, there are often great deviations and a lack of ethics that sometimes end in economic troubles.

Let us take a few examples:

– Wine making processes are mainly manual, as are the assemblies. Technical and administrative data are often entered manually. There are no direct relationships and interactions between the tanks/cellars and the computer system. When information is requested, a wine sample should be manually taken and analyzed. This decoupling means that there is a break (like a data breach!) in the chain of information, leading thus to a loss of control in the reliability and the control of processes.

– Some oenologists or some service providers, sometimes overbooked or overloaded, do not have the time to manage the risks related to the good quality of the wine products they are responsible for elaborating. They base their entire decision-making system on the data of the cellar master and do not take enough care to visit, audit the cellar and vats, even by sampling. Therefore, they cannot correctly and responsibly carry out their job.

– The accountants often work in the offices and rarely step foot in the cellars. They do calculations, sometimes with a calculator or automatically with computers, but… on unreliable bases (input and output).

– Some finance auditors, sometimes a little quickly, are just satisfied to work on "paper" or paperless inventory statements; sometimes they carry out quantitative checks, but seldom qualitative checks, whereas they are responsible and accountable for the reliability of the results (in terms of truth and sincerity) for the benefit of their clients or partners.

The current approach is therefore an open door to laxity. Computerization, which is not fully understood, poorly integrated and partially implemented, is the worst of the goods: people are sometimes disempowered and the current information technology, which can be considered as a weak digitization, is not yet able to compensate for human failures.

In contrast, administrative action has increased its power, with audit processes, regulations, taxes and charges, etc.

Within this context, the winegrower and the winemaker can find himself excluded from the process. Thus, in terms of ethics to be applied to the stakeholders: is it just and fair for everybody? Who is the victim, who is the offender? How could the equilibria be restored and recovered?

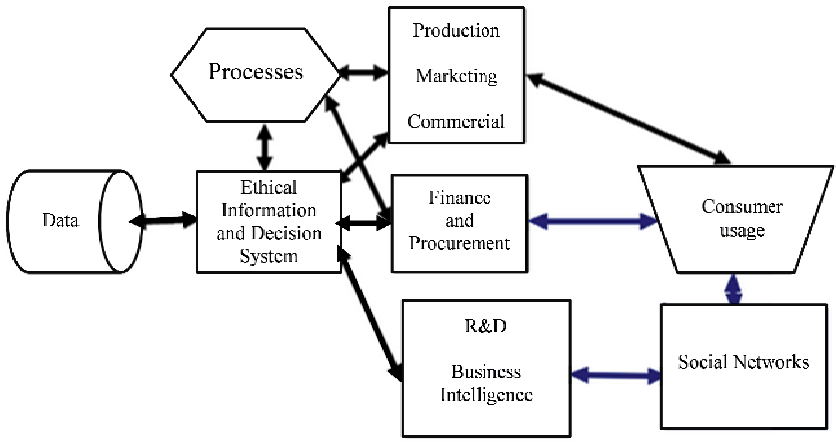

Figure 1.10. *A common information system: architecture and process interrelationships*

1.13.4. *"Data is centric"*

What is considered as a futuristic idea, but is not, is the way in which we must change our paradigms and ways of thinking. Currently, small initiatives are taking place to set up and integrate automata, step by step (e.g. grape harvesting machines, wine or cellar equipment, thermo-vinification, filtering, bottling, etc.). These are punctual advances, where everything is decoupled. We collect a lot of information, but which are sometimes incomplete, incoherent because we do not interact.

However, as we have said, the challenge of the next step is information: what is central is not the customer, but the data. All the organization, development and making relative to the wine industry must be built around the data. As for the CIM, the wine cellar master who does not always do a reliable job, the oenologist and the service providers who sometimes make mistakes will be connected to the information system (strong computing) more efficiently. Finally, the processes will be measured and monitored using IOT, while direct or indirect production operations and actions will be performed by robots or nanorobots.

In the diagram below, the processes of wine making are related to big data. The winemaker acts directly in the big data, while the big data system takes control of the process. As for the oenologist or the auditor, it is through and by the big data that he will see if a tank or a vat is empty or full, if there are no quality problems, etc. Customers also communicate their taste perceptions and ratings directly to the big data.

The rate of suicides among winemakers is double that of the average in society and wages are half as much [BRO 17, FRA 16]. For the record, most new vineyards in Argentina and Chile, which meet the criteria of intensive viticulture and para-bio, are designed around this concept to come because … it is only a matter of time. Here in the Roussillon, and for naturally sweet wines, is it necessary? Are we prepared? Should we turn to the luxury viticulture, and how?

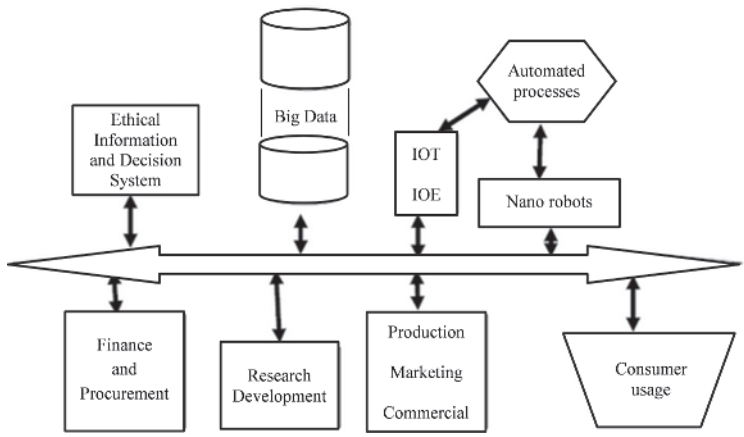

Figure 1.11. *Organizational model for a "big data-centric" system (© Pierre Massotte)*

1.13.4.1. *Business models: from information-centric to data-centric ethics*

Data ethics is a new concept that we need to consider. Indeed, data ethics becomes a science based on the ethics principles found in the computer sciences field (ethics about the hardware and applications: algorithmics, decision-making) and information processing (ethics related to the software: handling of quantitative, qualitative or unstructured, biased or not information, etc.). Data ethics refines these approaches, because of the huge amount of data considered, their fragile security situation, and because there is a shift, in terms of "level of abstraction" when we are doing enquiries: in information-centric systems, many handlings, interpretation and pre-processing are already done, while in data-centric systems, everything has to be done (specifically: selection of pertinent data, sorting, extraction of low noise, etc.).

We will say that data ethics refines the approach endorsed so far in computer and information ethics, with a change in the levels of abstraction (LOA). Let us call LOAI the "level of abstraction" in an information-centric system and LOAD, the one related to a data-centric system. Thus we have:

LOAD > LOAI

Data science is now part of the so-called information revolution. Its LOA still requires technological changes and adaptation, then new ethics developments to fruitfully conduct new ethical data analysis. This is not surprising since the MID industry developed a lot of new features (computers, tablets, mobile phones, online platforms, cloud computing and so forth): the digital technology requires different processing methodologies, associated with different ethical strategies.

The shift from *information* ethics to *data* ethics is probably more semantic than conceptual, but it does highlight the need to concentrate on what is being handled as the true invariant of our concerns. This is quite a different concept as the one discussed previously (called "robo-ethics"), and the conventional one called "computer ethics", more hardware usage oriented.

In data-centric systems, we have to integrate different types of ethics related to: hardware, software, but also social (with ethical problems such as privacy, anonymity, transparency, trust and responsibility concern data collection, curation, analysis, and use, etc.).

In light of this change of LoA [FLO 16]: *data ethics can be defined as the branch of ethics that studies and evaluates moral problems related to data (including generation, recording, curation, processing, dissemination, sharing and use), algorithms (including AI, artificial agents, machine learning and robots), and corresponding practices (including responsible innovation, programming, hacking and professional codes), in order to formulate and support morally good solutions (e.g. right conducts or right values)*.

1.14. How to link ethics and innovation

1.14.1. *Introduction*

In most companies, there is in fact a strong correlation between innovative companies and ethical companies: innovation is always considered as a competitive factor to foster the economic development and their business [GEB 14]. Are ethics and innovation compatible?

For that reason, independently to the amount of funding dedicated by a company to R&D, innovation must be considered as a culture: focus is sometimes brought to the number of patents (e.g. about 6,000 every year in IBM); innovation is often governed by clear ethical rules in medical care; ethics paradigm will be integrated in the software developments of games, etc.

To avoid deviances and deviations from standard usages, prototyping, experiments and after sales procedures and protocols will be implemented to assure the protection of the rights and welfare of research subjects. In doing so, this creates a presumption that advanced technologies and innovations that are not rigorously designed, developed and validated are ethically dubious.

Moreover, there is a pull effect in such a strategy: companies that foster ethics will likely foster their sub-contractors, partners and competition as well, because critical ethics values of respect and trust are protected, encouraged and rewarded.

1.14.2. *Some practices in innovation*

It is the responsibility of top management and technical leaders to be able to have ethics values such as consciousness, respect and trust flourish toward the best interests of others; they are accountable, both to themselves and to others.

For example, considering the system complexity we cannot predict which stable state will emerge for research, which result will be fostered or gained (NLDS) and what the impact on society will be: we cannot have all the answers available by themselves, and all the proposals coming from employees are welcomed. In the field of advanced technologies, we are going toward a participative and P2P organization.

Also: a manager who can admit a mistake creates a powerful example to others (*'errare humanum est, perseverare diabolicum est'!*). This means that it's possible to make mistakes, as long as one speaks up and takes corrective action, whether that action is to report misconduct, or is essential to the company's creative process.

When designing and implementing innovative technologies or programs in a company, it is important to ascribe some "best practices" in order for products to be successful and ethical.

First, we will always talk in terms of technology because an advanced technology is a set of several elements:

– technique, which is the key concept to be implemented for solving a problem;

– method, which enables us to define how to correct, improve and solve a problem;

– tool, which is the result of the development program, that many involved people will use to enhance the situation.

These three elements are always working together: ignoring one of them will lead to failure in the future. We have to keep in mind that evolution, in nature, is always performed thanks to a succession of disruptive events: if we do not implement disruptions in our minds and/or in our thoughts, ways of thinking and ways of doing things, we will miss the objective of a new technology. For instance: the message behind complexity is "reactivity"; the message behind the Web is "work organization", etc.

Hereafter are some important ethics factors [DAA 02] to consider in analyzing an R&D development program:

– Impact: how much difference will the innovation make to improve the present situation? How much will be the ROI (return on investment)?

– Appropriateness: will the intervention be affordable, robust and adjustable to morale settings in developing collective welfare, wellness, economics in countries, and will it be socially, culturally and politically acceptable?

– Burden: will the innovation address the most pressing, sustainable or priority needs?

– Feasibility: can it realistically be developed and deployed in an acceptable time frame? Will it be useful, usable and used, in order to assess the future costs of infrastructure and to monitor its sustainability overtime?

– Knowledge gap: does the innovation advance health by creating new knowledge, intellectual goods?

– Indirect benefits: does it address issues such as environmental improvement, income generation or additional impact (creation of activities opportunities, wealth and employment) …that have indirect, positive effects?

As with all EU or industrial programs, global innovations must be based upon best practice principles. In fact, decision makers have to act as if their own property, health and living were committed. The worst practices that are sometimes used by some organizations (administration, associations, etc.) can do significant harm and create substantial barriers if, for example, the decision maker is working with money that belongs to someone else.

Below are some questions that should be asked of any innovative technology or program:

1) Does the innovation involve local community members? Who is funding the innovation? For which purpose?

Deploying innovation requires understanding the local and global environments. Social, economic and cultural environments vary greatly across and even within countries, etc. Innovation implementation is a transdisciplinary activity that requires many different skills in sociology, anthropology, public policy, technology and economics.

2) Does the innovation foresee unintended impacts and consequences?

A global health intervention may lead to unintended and undesired consequences due to predictability concerns (complexity issues), possible errors, ignorance (all is not known about everything), and we are not able to know anything on the part of the developer or implementer. Since most of the systems are NLDS, we cannot anticipate the impact of an innovation: proper research and implementation procedures have to be conducted.

3) Is there a way to evaluate the success of the innovation?

Usually, evaluation needs to focus on measuring outcomes: financial, health and care, economics, technical, sustainability, etc. It is a global evaluation and validation that involves many participants and the society as well. Impact factors are always expressed in terms of metrics based upon amount of changes in behavior, attitude, skills, knowledge or condition of a target population.

1.14.3. *Ethical frameworks for innovation*

Many companies are not ready for integrating ethical behavior with the core behaviors that drive business success. Too many leaders have direct and urgent expressed financial, economic and resource concerns: they still talk about ethical culture as an “add-on”. They are aware about the “moral” concerns; then, in their internal audit charter, they sometimes add a rule of procedure called “acting with integrity” to soften aggressive values like “act with velocity” or “play to win”.

To contain the competition and ensure our own "self-development", we have to go further and define a framework to give a strategic vision, conduct, control and monitor the design, development and implementation of an R&D program.

Among the success factors to be covered by this framework, we can quote: utilitarianism, human rights and personal involvements. These ethical guidelines are lighted here below.

1.14.3.1. *Utilitarianism: the greatest good for the greatest number*

Strengths are defined as: encouraging efficiency and competitivity, profit maximization, looking beyond the individual to assess the impact of decisions on all constituencies. As a reminder, competitivity is defined as a set of four properties: quality, price, flexibility in volumes (productivity, modularity) and flexibility in product (diversity, scalability, personalization, personification).

Weaknesses are defined as: complexity (intrinsic and computational) leading to the global impossibility to quantify all important variables. Unjust, inequitable or unfair allocation of resources because of an asymmetric distribution of information, or "voice" representation, etc.

1.14.3.2. *Rights: an individual's rights should not be violated*

Strengths: to protect global health, security and any individual from injury. To establish spheres of freedom, standards of social and cultural behavior, independent of outcomes.

Weaknesses: encouraging individualism and selfish behaviors that interfere with social order, discipline, moral and cooperation. Non-preservation of competitivity concepts and sustainability BDI.

As soon as the room for leadership is becoming room for championship, the concepts of ethics is subject to interpretation and conducts to achieve business goals: ethics is not to remain on the margins in business decision-making.

1.14.3.3. *Enterprise: human resources involvements*

Specific behaviors that connect ethics and compliance with innovation and productivity must be encouraged to simultaneously achieve moral, cultural, social and business objectives. This requires us to improve the relationships and respect between the participants and stakeholders, to develop confidence and trust within the working organization. It is a question of sustainable HRM.

For that purpose, leaders must seek a workforce where everyone demonstrates high levels of personal involvement. Above all, employees at any technical or hierarchical level have to demonstrate an interest and sense of commitment to the organization, because they have to fight for safeguarding the organization and sustainability of their surrounding world.

Similarly, the working principles in use in the camps or quality circles (the "nine rules" of a cooperative team) have to be implemented to get a creative and efficient innovation process. It is based on respect and trust in others and any stakeholder or idea has to be listened to and respected: any information, improvement data and recommendation can be of most importance in any stage of the PLM (product life cycle management) of a new product or service.

1.14.4. *Conclusion on ethics and innovation*

Organizations are required to be flexible and to be able to take risks, when faced with uncertainties or unpredictable events. This requires a lifestyle and ethical attitude to make choices that are respectful, cohesive and which promote social harmony in the organization.

Ethics and innovation in our global world go hand-in-hand with social entrepreneurship. Today, it is regrettable that many people are creating a big confusion between morality, ethics and corporate social responsibility (CSR). We cannot substitute a given concept by another: all of them are complementary, and the goal is to combine, for instance, the passion of a social mission with business ideas of discipline, ethics with innovation, morale and determination.

As said before, not all innovations can be successful: the failure in an R&D program can also be fruitful and has to be handled as a success story. Indeed, we are no longer in the "business-as-usual" environment of the 20th Century. The new economy is part of a shifting cultural and business environment that includes robotics, nanotechnologies, the sharing economy, the gift economy, etc., and we must always learn from our failures. There are new concerns (results or hopes) that emerge from innovations: they can undermine the current economic systems but also provide new economic solutions and opportunities. Similar types of uncertainties, harms and doubts will emerge: they are also subject to ethics, to evaluate their impact and define the future actions to be undertaken within the development teams and populations.

Again, tighter interconnections and a sense of ethics between all the stakeholders is necessary: it starts with more and more global accountability, respect and honest communications, etc., continuing to develop a common trust, improving the overall performance of the PLM and implement new innovation capabilities in the R&D process.

Presently, efforts still have to be assigned to the definition and specification of a consistent set of ethics factors in a given innovation process. Therefore, we will not detail any work within this framework.

1.15. Conclusion

The world is becoming SMAC (Social, Mobile, Analytics, Cloud). That's good, but by being immersed in this culture, we do like everyone else and we must continue to grow to survive, to progress and to take the upper hand of life. To be competitive, we always have to stay a step ahead. One must be NBIC (nanometric, biological, internet and big data, cognitivism). However, ethics is both a necessity and an opportunity.

The winegrower and winemaker can already claim many characteristics and properties that are attributed to the human beings of the future, and thus to transhumanism. It will be reminded that, contrary to what one thinks, the winemaker is already completely immersed in this environment he is ready to assimilate, by what he is predisposed to, all the new paradigms from the future.

Finally, to return to his way of working, in the NBIC spirit, the professional involved in the operational matters can be considered as a forerunner: he knows the collaborative work (mutual support, resource sharing, cooperation), and multiculturism (followers of new practices such as organic, new types of consumption, etc.), the Uberization of viticulture, etc. Finally, and as a reminder: between his current life and that of the GIG, there are hardly any notable differences. It is within that context that ethics will have to be developed.