International Journal of Innovation and Applied Studies
ISSN 2028-9324 Vol. 4 No. 1 Sep. 2013, pp. 1-19

http://www.issr-journals.org/ijias/

A Science & Business Equation for Collaborative Corporate Innovation. Business Strategy, IP Strategy, R&D Strategy: an all-in-one Business Model. A review with a Bio-Technology & Green Chemistry Focus

Serge Rebouillat

Currently at DuPont Int, P.O.50, CH1218 Geneva, Switzerland

ABSTRACT: Not all the best people work for you... This is likely one of the motivator for open-innovation in terms of future business development. IP, R&D and Business strategies are becoming one. The adjacent technology analysis, ATA©, goes beyond prior art and freedom to operate traditional approaches providing a new role to the IP strategist still preventing excessive lawyering. Coaching and mediating turn out to be part of this role given the broad interdisciplinary and multi-science skills required.

Green chemistry and biotechnology are no exception since in essence they are multi-science founded and still today require an upfront pioneering state of mind. Largely regulatory driven the related businesses may enjoy the open-innovation approach even more or may end-up "not having the choice".

Two cases, involving advanced technologies in the sectors of Advanced Materials for Protection and Bio-based Material Engineering, are been used to illustrate the suitability of the proposed collaborative and participative business equation.

This review, mostly intended for educational purposes, using illustrative situations close enough to reality, establishes a state of the art foundation for the layman and unexposed professionals. A number of fundamental references, more than 12 foundation books are cited to provide to the implementer a self-standing source of established literature.

KEYWORDS: Innovation, collaborative, participative, Collaboratory™, adjacent technology analysis, ATA©, biotechnology, advanced materials, hybrid vehicles, green chemistry, $4C^2$©.

Disclaimer: This article is primarily for educational purposes. Selected cases are strictly illustrative and for most derive from simulated situations. Neither the author nor the illustrator assumes any liability for any errors or oversights, or for how this article or its contents are utilized or interpreted, or for any consequences resulting directly or indirectly from the usage of it. For any guidance, legal or any other, seek advice from the appropriate professionals. The opinions expressed by the writer in this article do not necessarily represent the viewpoints of the company the author is employed by.

INTRODUCTION

About 15 years ago, in the French Chemical News, [1], the author described the innovation path using the skills of the modern business engineer. The selected 4C© skill elements were CONNAISSANCE – CREATIVITY – COMPETENCE – COMMUNICATION. Those skills were to be aligned with the need of the new global business environment. In other words the business engineer would have to be a Creative-Connoisseur and a Competent-Communicator and/or almost of any profile corresponding to any combinatorial arrangements of the four word roots, 4C©.

Would 4C© suffices and survives today? Probably not! What about $4C^2$©? Foresee Square is depicted on Figure 1, with the Collaborative word added to each and every 4C© skill descriptor. Therefore, the business engineer is part of multiple networks of interactions called most of the time the open innovation network.

Corresponding Author: Serge Rebouillat (serge.rebouillat@dupont.com)

This study combines and complements the presentation at the Geneva Corporate Innovation Forum of October 6th, 2011 and the plenary lecture given at the International Symposium on Green Chemistry held in La Rochelle on May 21-24th, 2013.

According to the Environmental Protection Agency (EPA), [2],[3], an independent US federal agency, "green chemistry" is defined as:

"…The design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. Green chemistry applies across the life cycle of a chemical product, including its design, manufacture, and use."

As outlined in [4], [5], [6], the Green Chemistry (GC) arena involves multiple Science and Technology know-hows. Food, Bio, Chem. Engineering, Physics and Environmental Sciences are more than essential in the creation of a sustainable business environment based on Green Chemistry. Fundamental understanding, mathematical models and design methods, such as in separation technology [7], [8], and energy rationalization method [9] have been and remain vital in the process anticipations and transfer from their more traditional arenas of applications to the ones of concern hereby, in GC.

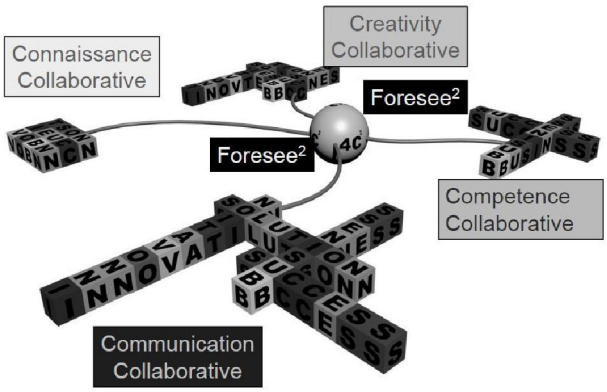

Fig. 1. Foresee Square, 4C²©

Also underlined in [4] and supported by patent strategy [10], IP awareness and vigilance is critical: offensive and /or defensive, creating value and/or distributing value. The challenges between creating value opportunities and strictly controlling and distributing value, subtend the business opportunity within its rather fast evolving boundaries.

The State Intellectual Property Office (SIPO) of China, [11] recently facilitated examination of patent applications directed to various strategic technology areas, including green technologies, GC therewith.

The explosion of design patents in China, more than 500 000 in 2012, i.e. 10x the USPTO or the EPO numbers, has been reported at several occasions by the specialized press. Also described is an "All-time high for activities of the European Patent Office in 2012" which tend to put patent growth in a worldwide context.

The private sector owns a majority of the green chemistry patents, close to 90%. The university holds a relatively large portion as well, close to 10%, outlining its role as a pioneering entity.

In terms of classifications, the world number one company in terms of portfolio count in 2012 is ranked number 3 in the brand value classification; the company ranked number 6 in the brand value classification in 2012 is also ranked number 6 in terms of the portfolio count ranking. Three of the 6 first patent portfolio counts are part of the 10 first valued brands.

Brand and patent count classification seems to get closer as patent portfolio average quality improves with time, i.e. a better alignment of patent strategy with business strategy. The race for "patent count" might be in obsolescence. But the race is still on, slowly shifting towards a "quality rather than quantity" based race.

Brand is definitely a business asset which is reinforced by the patent portfolio although in the first ten classified brands, there are companies operating on the basis of trade secrets or owning very few patents.

Patent portfolios are part of acquisitions which can reach several billions only for the patent asset part; monetizing patent assets is definitely an element of the business equation. Computer/software related patents are leading the way, as well as smartphones and social networks.

To place things in prospective, in the same study, Oliver Wyman underlines that 90% of high technology patents, including GC classified ones, are priced less than $50k; 9% between $200k and $500k and 1% worth above $1m.

According to "Updating TRIZ: 2006-2008 Patent Research Findings," minor and continuous improvements constitutes about 60% of the average patent portfolio while only 5% are of pioneering nature which in turn accounts for more than 70% of the portfolio overall value. Then the majority of the patents accounts for less than 25% of the value of the given portfolio.

Despite the refining and improvement of the examination process of patents, there is still a focus on eligibility versus quality.

Given previous considerations and related reflections, is there a new business equation?

A RATHER NEW BUSINESS EQUATION

In summary most of the time IP strategy, R&D strategy and Business strategy can no longer be separated and need to be linked. The three are to be integrated and harmonized in order to lean towards a more adapted and ideal business equation with an upfront business model analysis and implementation roadmap, i.e.:

1- Maintain Superior Competitive Position

- Minimizing elapsed time from idea to market

2- Ensure Business Flexibility

- Maintaining and expending the freedom to operate

3- Secure Business Profitability

- Minimizing legal/competition exposure

IS IT THAT COMPLICATED?

The artist "BSR" has interpreted, Figure 2, a virtual patent claim relating to the hospitality industry, "Apparatus and method to serve hot beverages, preferably coffee, without losing the human touch".

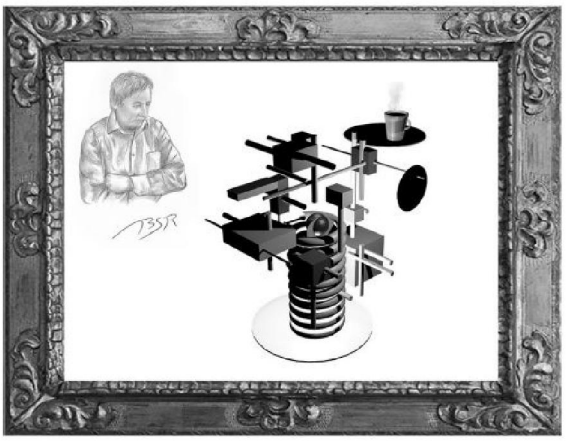

Fig. 2. That Complicated?

Obviously it can be complicated to interpreter some claims, isn't it? The GC area isn't apart from the raising complexity and length of patent applications related to bio matters.

The IP and Innovation strategies definitions need to be synchronized with the business models establishment phase using well adopted business development and IP stage gate processes. The latter being part of an evergreen monitoring process (in term of strength and weakness awareness) which should also be in place to:

1-Monitor the IP progress

2-Refresh awareness of already in place secured technologies, via express inventories

3-Identify wish and must happen filings and acquisitions or divestitures

4-Broadly recognize (manpower, resource, time) limitations of wide-ranging implications

5-Regularly revisit lists of unexploited and unexplored technological traits

6-Reformulate the ideal stage

7-"Looping" back to most appropriate stage 1-5

The aspects above will be illustrated in the remainder of this paper using a bio vs. a non-bio undertaking and various company IP profiles.

THE GREEN CHEMISTRY AND THE REGULATORY IMPACT

Let's now focus on the GC sector and have a closer look at the ISGC2 international GC symposium [12] using it to unveil various trends and to analyse the alignment between the key players.

As a matter of curiosity, as soon as we have been invited by the organization committee to present a plenary session on the open-innovation matter, we decided to conduct a relevance analysis and alignment check of different subject matters covered in this symposium.

Regional authorities, with "ex" national and international political mandates, are persons of choice to deliver introductive opening speeches; no exception for the current symposium [12].

Using the main address of the meeting ISGC2, we performed a technology and business model relevance analysis using state of the art patent mining engines [13] and tailored methods and sequences therewith, as well as non-patent literature (NPL) computerized analysis with "artificial intelligence" capabilities. Especially tailored for this sort of purpose, combinatorial sequential analysis was used involving those engines' capabilities. In the remainder of the text we will use the acronym ATA©, adjacent technology analysis, when referring to those tools and methods.

Those computerized approaches remain for the most a bit murky in defining the used algorithms and procedures therewith. The main unique characteristics of the patent and NPL mining sequence that we tailored and use for our purpose, ATA,(that distinguish it from traditional patent search systems), are to the best of our knowledge as follows:

(1) topic-idea-driven; (2) heterogeneous networks co-searching; (3) smart competitive analysis incorporation, and (4) whole patent or NPL integration.

A seminal reason for deviating from traditional keyword and patent classifications based searches is grounded with the following type of studies.

As reported by Ulrich Schmoch, of the Fraunhofer Institute for Systems and Innovation Research located at Karlsruhe in Germany, to the WIPO organisation in June 2008:

"Various technology classifications have been used by different institutions for many years. These classifications generally follow the systematic of specific patent classifications, either the International Patent Classification or the US Patent Classification.

However, these classifications have proved to be quite inconsistent in various aspects."

Note: References to commercial brands and to potentially interest conflicting specific matters are being proscribed in the ISGC2 presentations. Therefore tool names, such as search tools, are simply not mentioned at all. Furthermore the tools are being used in combinatorial fashion, and then it would be hard to evenly and fairly represent the contribution of each of them. (The same restrictions are applied to company names and product names all along this presentation, which is based mostly on the plenary lecture given by the author at that symposium).

Among the 100 most relevant references, deriving from the patent mining and NPL ATA analysis of the main address of the symposium (available in the proceedings of the event [12]), came in position 3 the following reference title:

"Ethically coherent and scientifically logical method for allocating assets in portfolios of investments"

Without any partisan predisposition, this happens to constitute a "discovery". Somehow it is also a compliment which can be addressed to the mentoring supportive authorities and the scientific committee, since this reference supports hand-in-hand relevance and coherence within the GC context.

Let's the abstract tells us more:

"The present…concerns the technical aspects of applying ethics to the field of investment industry. It provides an ethically coherent and scientifically logical Method for allocating assets in portfolios of investments and a model Fund product that applies this Method to detract systemic tensions…This is a novel mechanism to provide equality in access to both information and credit and thereby contributes to: - a stable increase in financial return on investments;- an optimal allocation of human resources through the creation of employment in both hard and soft currency countries, and - an environmentally optimal depletion of natural resources.... The implementation of the project is assisted by a computer program and a data base product, and monitored through an ethically coherent business organization method."

This may contain the right wording to complement the previously cited EPA definition of Green Chemistry where ethical coherence and scientific logic pairs towards and environmentally optimal use of natural resources, an harmonized use of human resources and assets…in global collaborative industrial undertakings. It also brings to the front stage, the regulatory aspects which have led the way to the Green Chemistry (GC) journey since a number of years.

Additionally this excerpt is pertaining to a patent document published on June 7th, 2007.

IP is at the heart of the GC development. The creating value opportunity may overpass the traditional distributing value paradigm. The role of the regulations is prominent, but will not be further covered in this paper beyond the following assenting citation [14]:

"Empirical data have identified legislative and regulatory pressures as the main external forces that promote the adoption and innovation of cleaner technology and environmental management systems, followed by cost savings and market opportunity."

GREEN CHEMISTRY AT THE WORKBENCH

There are some level of correlation between public R&D and patents for alternative energy technologies (wind, nuclear fusion, photovoltaic); but not to the same extend in the case of fuel cells, probably since private R&D is very important, [15].

The above suggests that patent numerals and R&D allocation can be a reasonable proxy of not only inventive activity but also innovative activity.

Therefore let's attempt to verify some of the above in the case of the current symposium, [12].

Given the interconnected areas of GC in general, the identification of eco-patents requires adequate knowledge of the technology under consideration in order to determine:

1. How much is being patented?

2. In which regions and which sectors is it being developed?

3. How does the related patent activity compare across different topics, such as the one selected for this symposium?

4. What does this patent activity reveal about the drivers for innovation? Which type of innovation? Is there a choice?

Using the above 100 most relevant references, related to the editorial address [12] ATA analysis, a further ATA analysis is performed to determine the most relevant clusters representing recurrent concepts; in other words, "relevant ideas" sum-up by key words called text clusters.

The analysis therewith is shown on the left side of the graphic of figure 3 wherein the credits cluster is dominant followed by carbon dioxide, sustainability, renewable energy and power generation. This representation can be, for an illustrative purpose, considered as representing the authorities' vision, directions and somehow expectations for that event and the GC prospects in general.

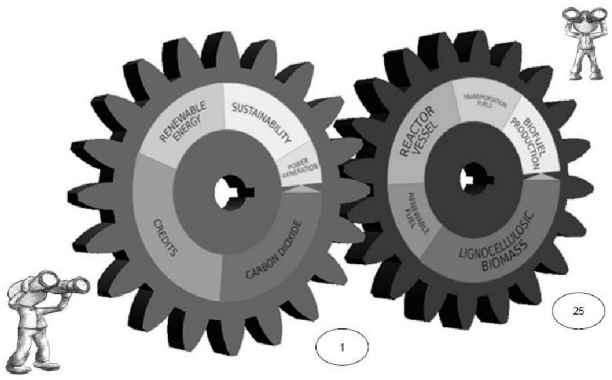

Fig. 3. Authorities vs., Experts

In terms of alignment and coherence analysis, a logical extension of this type of analysis can be undertaken with further comparisons involving the domains of interest of the three categories of ISGC2 intervening presenters; i.e. the authorities as being the visionaries, the plenary and key-note lecturers as being the experts and the oral and poster presenters being the trained in the art senior researchers and the workbench actors.

For that matter, titles of plenary lectures and keynotes as well as round table subject matters, [12] (25 in total), are processed via ATA, patent mining and NPL analysis, to obtain the 100 most relevant references related to those. The resulting text clustering analysis and the disc representation is provided on the same figure 3, on the right side this time. The resulting domains are for the most relevant: lignocellulosic biomass, followed by reactor vessel, renewable fuels, biofuel production, transportation fuels. Let's assume for an illustrative purpose that this analysis represents the experts' vision, directions and somehow expectations for that event and the GC prospects in general.

A quick comparison between the authorities' clusters and the experts' clusters reveals strong overlaps such as the renewable energy and the bio-fuel domain in particular. But also a difference, i.e. on the authorities' side appears: credits, carbon dioxide, which may be related to the debated climate changes, sustainability. On the experts side the production and engineering aspects are differences worth being remarked.

Overall there is no conflict in the cluster analysis and all matters remain part of a logical vision and directions therewith.

Still keeping an educational purpose in mind, the figure 3 analysis can be extended. Figure 4 provides the results of the analysis combining the authority and the experts together on the left side and the researchers on the right side. For the latter more than 600 entries have been used namely the oral and flash presentations titles and the posters titles, [12].

Let's adopt that the researchers are mostly the workbench actors using the currently available research tools. Figure 4 translates a focus on the biomass which is also a major focus for the combined authorities and experts. Otherwise a product orientation, rather than a process and a production penchant, appears in this analysis. Once more this is an illustration of the use of ATA IP/NPL processing tools. One can freely derives other conclusions from the proposed disc charts.

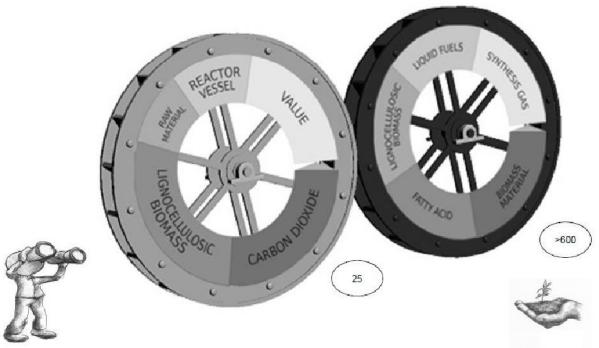

Fig. 4. Authorities & Experts vs. Researchers

IS IT HAPPENING NOW? ESTABLISHING PRIORITY AND REGIONAL DISTRIBUTION

Each topic, selected by the ISGC2 symposium scientific committee, was submitted to an ATA to qualitatively determine whether their relative attractiveness and their regional distribution are homogeneous or rather spread around.

Namely the following topics were considered, [12]:

- **Topic 1:** "Conversion of lignocellulosic biomass.
Pre-treatment, deconstruction and conversion of lignocellulosic biomass to chemical platforms or transportation (renewables: wood, corns, beets…)
Conversion of carbohydrates to higher value added chemicals"
- **Topic 2:** "Conversion of vegetable oils, derivatives and by-products.
Conversion of vegetable oils
Reactions involving (unsaturated) fatty acids/esters, glycerol or minor compounds (esterification, transesterification, oxidation, metathesis, hydroformylation, hydrogenation ...)"
- **Topic 3:** "Valorisation of by-products (including CO2), waste and recycling.
Chemical valorisation of waste
All processes involving biogas and more generally agricultural waste
Chemical valorisation of CO2"
- **Topic 4:** "Eco-efficient processes.
Design of energy (and atoms)-saving processes for the rational conversion of renewable carbon
Chemical and physical pre-treatments of biomass, green solvents, alternative media, catalysis,
Process design, process intensification..."
- **Topic 5:** "Catalytic materials specifically dedicated to innovative processes incorporating bio-based materials.
Preparation and characterization of materials for the selective conversion of biomass: eco-design, green synthesis, bio-sourced precursors..."
- **Topic 6:** "Environmental impact of all actions implemented.
All works evaluating the ecological impact of chemicals and processes on the environment."

Figures 5 and 6 show the filing dates of the series of patents, which were found most representative of each topic, by means of our ATA analysis.

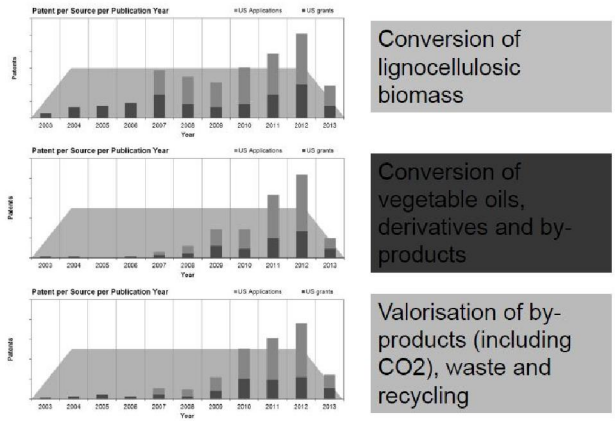

Fig. 5. US Applied vs. Granted

All topics enjoy recent filings, the period from 2005 to 2012 encompasses the peak periods for all topics, which means that all topics are paving the way to the GC innovation; within the symposium topic selection of course. Topic 1 related to biomass conversion presents a more continuous filing trend. Topic 4 related to catalytic innovation exhibit a filing peak in 2009.

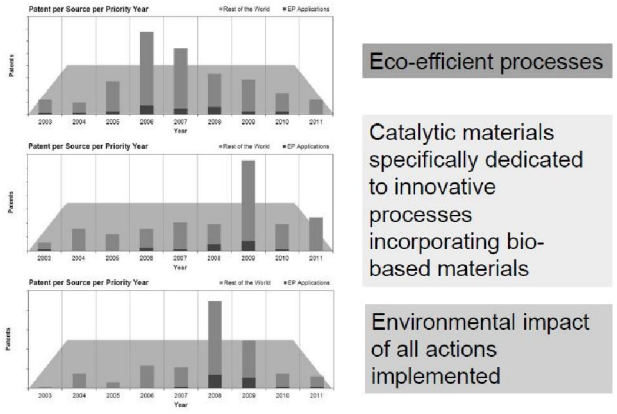

Fig. 6. EP Applications vs. Rest of the World

On Figure 5 one can segregate applications vs. grants in the USA. Filing dominates which means that one should expect enforceability of those patents in a near future. Within the limitations of a qualitative interpretation, if the ground has been set by those patent family applications, then, the "new" business equation could be a predictor of the potential success.

Extending the ATA analysis to the world IP distribution, Figure 6 confirms a rather well anticipated dominant position of the rest of the world, versus the European applications. This trend seems to be a relatively long lasting one, [16].

Is there something to learn from the innovation models in place and could newer models be of value to GC (Green Chemistry) technology worldwide; more specifically in balancing the attractiveness and enforceability of innovative GC?

INNOVATION PROFILES: WHAT'S NEW AND APPLICABLE TO GC?

There are multiple ways to handle partnership and IP strategy, [17], [18], [19], [20]. In a bipolar classification of those, one pole corresponds to the almost totally externalized IP and innovation activities and the other pole relates to the strictly internal R&D and IP protection scheme.

a- The Open Structure & Network Therewith [21]

An illustrative structure corresponding to the open structure pole is depicted on Figure 7 wherein the relationships are mostly defined by two ways agreements. The resulting IP, most of the time patents, is shared. On this slide one can appreciate the IP fluxes, e.g. number of patents shared and licenses, from the thickness of the lines which connect the main entity (Comp.1 on Figure 7) to its contractors and partners (2,3,4,5… on Figure 7) – the higher the flux the thicker the connecting line. This of course goes beyond known in the art "passive" co-ownership.

It is worth to notice that partners and contractors do establish their own networks with other actors of the open structure.

This type of working relationship with partners, suppliers, etc., being able to establish their own networks within the principal network, has been frequently questioned with regard to loyalty and strategic "solo" opportunism.

There are means to minimize and monitor this type of risk as well as to discourage the opportunistic behaviour. Neither traditional policing nor "hostage taking" dispositions are necessary. Reversely, encouraging and enabling, and creative value development may favourably replace distributive value creation such as traditional price, volume, time pressure "incentives".

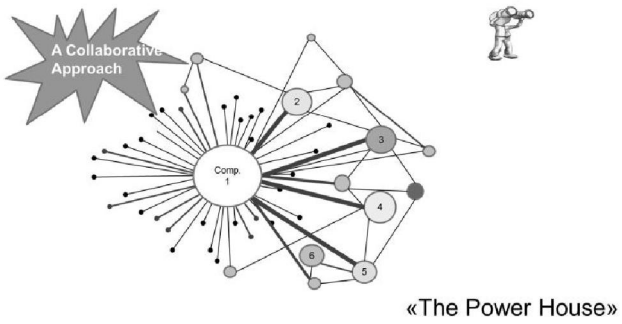

Fig. 7. An Open-Innovation Supplier Network [17], [21]

Most encountered eight dispositions to create a reasonably virtuous partnering network, with sub networks as depicted on Figure 7, are listed below using self-explanatory semantic.

1. Establishing and managing a reciprocal commitment process
2. Adopting a process for the avoidance of the most common pitfalls
3. Clarifying the prospect of future deals
4. Favouring reciprocal value exchanges and value creation versus strictly value distribution schemes
5. Monitoring constructively and putting in place early warning mechanisms
6. Instituting efficient and easy to manage compensation mechanisms rules
7. Avoiding hard bargaining tactics and excessive-lawyering
8. Anticipating and eliminating "need" for hostage taking tactics and/or narrow minded strategies to strictly insure return on investment

This networking and partnering approach, is frequently referred to the "Power House" when describing a major car manufacturer, number 10 in the current brand value classification.

On purpose, we are skipping the psychological and cultural hurdles that may affect the implementation, nurturing, maintenance, monitoring, etc. of the open structure. Those are to be appreciated on a case by case basis. They seem to surface mostly when regional versus global selective needs and wishes are expressed. The advent of emerging economies and blocs, such as BRICS, represents a significant pressure testing in that field too.

b- The Strictly "Internalized-close" Structure & Controlling Network Therewith [22]

Between overconfidence in internal means, i.e. tools and creative resources "being considered as the best in kind" – and – the rational confidence based on well managed and long established state of the art controlling organization, there are numerous intermediate scales.

Today most of the time the overconfident internally focus organization suffers from an outside perception of obsolescence, related to a rather long admired internal "university" format consisting of the centralized research and development of most large corporations. Those R&D organizations were generally used to generously allocated high quality manpower and funds; therefore producing Nobel-class science and discoveries therewith.

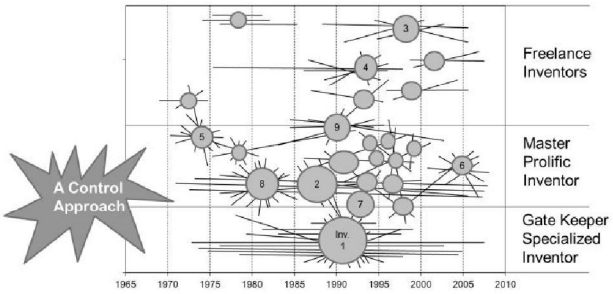

Fig. 8. A Patent Portfolio and Inventor Profiles [17], [22]

As a matter of fact, there is nothing wrong about the controlling scheme depicted on Figure 8. Different innovator profiles can be characterized from this strictly internal innovation structure.

One can easily identify, bottom-up:

- The legendary gate-keeper focusing year after year on the maintenance and evolution of trade secrets and patent fortress therewith.

- The, coaching style, technology master, capable of creating year after year evolving generational technology packages with awareness of the routes to market and the business models. The coach style technology master (CSTM) is well versed to communication, nurturing and empowerment of less experienced innovator generations or to help redirect already in place more experienced researchers.

- Freelance profiles, sometime perceived as “unmanageable” intrapreneurs (conversely entrepreneurs), take part to such controlling organization and are likely to bring non-core innovative solutions. They come generally from the problem solver side of the research organization; generally originating from the sometime less appreciated problem spotter side of the business organization. One often refers to the famous yellow tag discovery story when referring to such a freelance approach.

Additionally, one can also mention successful business entrepreneurs who developed computerized social networks from a problem solving approach; most of the time “improving and transferring” rather than discovering.

Undoubtedly, the controlling structures of interest in this paragraph can benefit from those innovators, gate keepers, and coach masters’ styles beyond the layman’s view.

In the shaving business, the continuing innovation, - in razor evolving from one blade to beyond 3 and 4 blades -, is almost self-protected by its innovation history and well established background. Furthermore, the multiple integrations of various patented accessories, well-engineered around the shaving core technology, add durability to this protection; sometime resulting in a fencing of more than 50 to 70 patents surrounding the main base product. The number 16 in brand value current classification, deserves some attention in that respect.

With more than 1000 granted patents, razors have evolved as one of the most patented consumer products.

Among other tied accessories and products, using control mechanisms to ensure market dominance, are:

• Printers and ink cartridges / Coffee machines and capsules / Mobile phones and shared time / iPods, MP3s and iTunes and the likes / Low cost computers with linked Internet services / Cameras and lenses / Game consoles and games / Electric toothbrushes and brushes…

Some chemicals and their associated delivery / conditioning / dispensing systems could fall within that category. Some GC products are well adapted to such an approach given, for example, their shelf life, dosage recommendations and eco disposal requirements.

c- Adopting either an Open or a Controlling Profile; anything else? [17]

In between the open and closed innovation models described previously, number of collaborative patterns and IP protection schemes exist. Several matrix representations have been proposed to outline the various business risks versus the IP strength of various partnering dynamics.

We propose to maintain the usual four quadrants positioned in a dual axis as represented on Figure 9 with some modifications relevant to our pertinent experience.

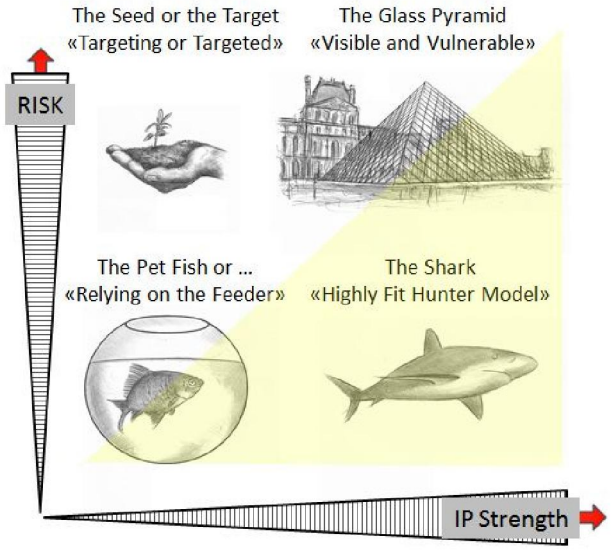

Fig. 9. IP Strength vs. Risk Profiles [17]

The lower left corner depicted with a pet fish in its close reduced bowl environment corresponds to a low risk, low IP strength zone, furthermore lacking privacy in our representation. Diagonally, opposite to that zone the glass pyramid, recently designed to serve as the lobby of the Louvre notorious museum in Paris, represents the high risk but highly rewarding IP strength zone. Worth noticing the analogy between the valuable fine arts located in heavily protected areas and the IP protection, with regard to trade secrets, etc…

Rather logically the lower right corner quadrant is the high IP strength-low risk area where the fit professional hunter, such as the shark, can dedicate most of his time to food hunting given the guaranteed reward; although… Buying and selling patents, bargaining and challenging IP positions is a recent tactic, familiar to capital ventures generally driven by and for the promotion of innovation.

The last quadrant, i.e. high risk-low IP strength, could be either voided since this voided zone may be the place where any actors, of the three already defined areas, may unfortunately end up. It may also be populated as we did with a tree in its early stage. The pet fish may for example starve as soon as his dominant construction customer tends to suffer from a building confidence crisis. Similarly the shark may venture across highly contaminated water frontiers and the glass pyramid tenant maybe targeted by competitive intelligence abusers well-armed to capture trade secrets. Then all three are likely to end-up in the high risk- low IP strength zone.

That last quadrant may also be the start-up companies' zone looking at the best strategy to value, monetize and cherish their blue sky ideas and discoveries. It may be a temporary position pending on the real or inspiring value of the technology which they nurture. The discovery may reveal a high potential rather soon than later. This quadrant is also the one for low cost, close to no IP owning businesses.

This specific quadrant reaches beyond the scope of our paper. Nonetheless in a few words, here are aspects to take into consideration:

- for most start-up companies, conceptualizing and mounting a comprehensive patent portfolio can be exorbitantly expensive

- therefore the need to establish, earlier-on, business objectives, IP and product roadmaps and multigenerational business models, with adequate external support; without excessive lawyering but well-tailored IP strategizing.

Of course many undertakings may enjoy a tremendous collaborative life style, with growth and sustainability, having elected for combinatorial positions on the orthogonal axes of Figure 9, pending on products and technology maturity, recent acquisitions or divestitures.

d- Avoiding the Most Common Pitfalls

There are several processes which may be used to safeguard joint developments and to help establish a multigenerational product roadmap with secured IP and business models therewith.

The House-of Quality, the Quality Function deployment (QFD), the Voice-of-Customer (VOC), the Theory-of-Constraints (TOC), the integrated Theory of Inventive Problem Solving (TRIZ), Six Sigma, etc. have paved the way to promote best practices, boost and secure the innovation processes and routes to market of multigenerational products and processes, [23], [24], [25], [26], [27].

Most of these approaches, individually or integrated in innovation management processes, have now got Wall Street's attention and became prerequisite to a good design of a portfolio of products. Although not so long ago Business Models were missing or developed as an after the fact "justification" or became the "most natural" way to proceed without being truly engineered for it.

An innovation pathway, for defining and meeting customer desires in an open innovation frame, was adapted and named by the author as "Z-process".

Z-process includes the following steps:

- Market Survey
- Target Definition – Research and market Targets based on:

 Customer Visits, Trade Literature, Technical Symposia, Competitive Activity, Patent Literature,

- Speculative Research and Discovery Process involving:

 Testing and Evaluation Iterations, Candidate Selections

- Process Development with:

 Early assessment by SHEA (Safety Health Environmental Affairs) department vis-à-vis REACH and other registrations and compliances,

- Pilot Scale Manufacture
- Full Scale Manufacture
- Launch Phase
- Establishment Phase

None of the above steps can reasonably be conducted without an IP and Innovation gate process to establish, validate, consolidate, reinforce the IP sustainability in terms of patents, trade-secrets, trademarks, internal records and agreements therewith (e.g. CDAs, MTAs, JDAs, PRIs (patent right agreements), CSA (Commercial Supply Agreement), BUA (Brand Use Agreement)…).

Each and every step of the Z-process involves multiple partners, internal as well as external, in field trials, customer evaluation and/or validation for example. Therefore the pioneers, researchers, technologists, customer service groups, marketing specialists, financial experts, consultants, salesmen, and business strategists are all at a certain stage involved with external partners, agencies, specification bodies…

The open innovation format implies the joining and active involvement of external resources at each and every step of the innovation process, and, not only at the final commercial stages such as in most close innovation paths. Those external resources are coming from outside in the same direction of, or, parallel to the usual operational boundaries of the firm. Those are generally described with a funnel shape, directed towards the market adoption.

One of the major pitfall lies with the management of such complex level of interactions, occurring in iterative simultaneous processes. The IP protection insurance and the innovation strategy are of evergreen vital importance. Close coaching and consultancy beyond administration and legal attention, is ideally performed by the innovation strategist well versed in IP matters, with a broad experience and knowledge of business and technology functions – a rather new and emerging role requiring strong mediation skills.

In order to limit adverse consequences, a best practice policy within an open innovation context shall take place along the following lines.

Here are three phases of the open innovation journey with most cited deliverables:

1. Exploration – the parties explore the possibility of working together, a mutual one-way or two-way confidentiality agreement being in place. Sample and/or material transfer agreements may be used in this incubation phase.

- "Identification of Interest Areas, Business and Cultural Fit
- Clear Understanding of what each Party Brings: Technology Expertise & Areas of Interest
- Open Discussion
- Agreement on Vision for Success"

2. Joint Development – the collaboration/joint development/research agreement is written and work takes place. Triggering milestones in the integrated joint work plan shall be well defined to cascade to commercial joint undertakings. An exploratory separated research agreement may be recommended for uncertain or hard to define complementary joint purposes. A Patent Right Agreement (PRA) shall preferably be included in the forms of integrated obligations or a commitment to establish, based on well laid down preliminaries, a foundation usable on due course.

- "Initial Testing to Develop Joint Technical Statement of Work
- Successful Laboratory Test & Proof of Concept
- Joint Technical Plan
- Understand Value Chain"

are the expected most common deliverables.

3. Commercialization - a product or technology is made ready to take to market and to produce financial benefits under licence, acquisition or other customized commercial agreements.

- "Successful Field Test & Valuation Model
- Market Success for Both Firms
- Understand Valuation Thoroughly
- Equitable Division of Profits"

are associated deliverables.

e- There is barely no sustainable IP strategy without evergreen business models and reversely: their alignment is paramount and vital [28]

In the US more than 80% of the patents applications are granted. In Europe, the EPO grants about 70% of the patents applications. This cannot be generalized in all sectors and some changes are occurring. There are not many monetizing or investment offers that can provide such a return %. Let's remind this Steven Covey principle:

"If you don't know how you are going to monetize a patent before you apply, you are never going to monetize that patent."

IP is truly part of the business model, which among others, defines the routes to market, the technology and IP roadmaps, the multigenerational product offerings.

Figure 10 shows an example of a supporting roadmap, starting from ingredients on the left side to meet end-users' needs on the right side *(depicted cie names and logos have been created from scratch for illustration)*. The multiple paths are all secured with IP gates (vertical ovals).

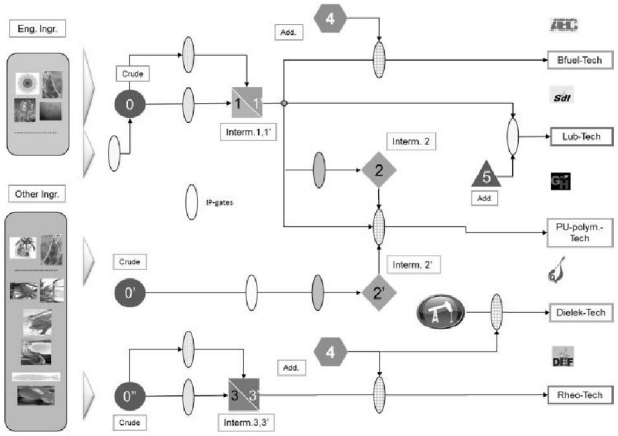

Fig. 10. An IP and Technology Roadmap – illustration only

Such a roadmap is the result of an evolution process taking place over several years; most frequently starting from a discovery exploited in a sequential or parallel manner to deliver right on time the desired goods. Ideally those deliverables are in line with the business models' best prediction of the right-on-time monetization or profit optimization vs. external and internal driving or inhibiting forces. Acquisitions or divestitures are also part of this market dynamic and may reveal much faster and more profitable than internal developments or licensing in/out.

- **Special or "trendy" or becoming the norm: business models and patent strategies in multi-invention contexts.**

One could dedicate a full course on this matter. A paper proposal is under preparation on this aspect. At least one ought to make reference to this aspect given its prominence in the biotechnology sector and GC in particular.

Frequently said, the more technologically interrelated the multi-invention offerings, the bigger is the challenge to manage with other partnerships and to follow an open innovation course. On the other hand the bigger is the business opportunity, in spite or thanks to non-core technology challenges.

Maintaining a comprehensive technological benefit across multiple arenas can be hard, if not unbearable. The larger and more diverse the set of technology fields, the faster they are rolling, and, the more an integrated model will suffer to stay competitive. In those situations we refer the reader, to Figure 7 and 8 and to the proposed ATA approach to keep abreast, well connected and supported by the surrounding functions of the firm.

DISCUSSION & CONCLUDING REMARKS: WHAT CAN WE LEARN FROM SOME ILLUSTRATIVE EXAMPLES?

1- Pertaining to the Green Chemistry Field: an emerging Science and Technology, [29], [30], [31]

Non fossil oils, such as vegetable oils, animal fats and wood derivatives, have several advantages to petroleum-based oils including lubricity, lower volatility and a high flash point. However, they may suffer from a lack of oxidative stability that can prevent their use in certain high temperature environments. High oleic containing oils, such as soybean oils, have exceptional heat and oxidative stability and can be used in high temperature and extended use applications where conventional commodity oils are not an option.

Lou Honary, [30], has done extensive work on the evaluation of those products.

Applications may include:

1. Lubricant formulations
    i. Industrial and food grade hydraulic fluids
    ii. Metal working fluids

iii. Greases
iv. Chain bar fluids
v. Motor and gear oils
vi. Marine
vii. Automotive

2. Dielectric fluids
3. Polyols, plastics, foams, adhesives
4. Source of oleic acids for oleochemical production

Let's imagine that a major discovery in the field of high oleic oil took place back and close to year 2000.

On Figure 11 we are providing a representation of the backward and forward citation levels of this breakthrough, using our own phase descriptors and sequence therewith, i.e. Incubation, Breakthrough & Impetus, Momentum and Inducement.

As shown on the Figure 11, the considered invention has developed into a well forward cited breakthrough, therefore a breakthrough as per the verbatim definition, and not a well sold and masked continuous improvement.

The number of patents that this breakthrough, induced or inspired is far superior to the patents that may have served an incubation role prior to the discovery.

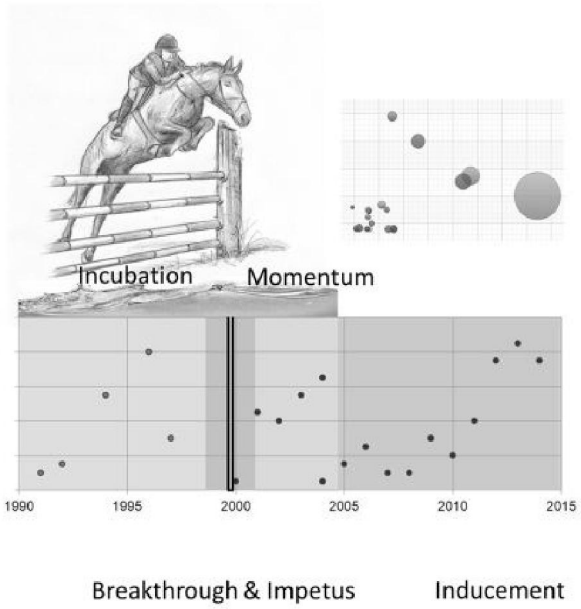

Fig. 11. An Inspiring Breakthrough

Conclusion 1: each GC discovery ought to be treated as a potential breakthrough then the above phases are "manageable" and should be managed preferably in an open-innovation process.

Otherwise as depicted on the circle representation of the upper right corner of Figure 11, the follower, possibly your contractor/processor, represented here by the biggest circle, may take over and leave you little room to manoeuvre given his skills to formulate the ore.

2- Pertaining to the more Traditional Field of High Performance Materials and Protective Systems, [32], [33], [34], [35], [36], [37], [38]

The job of keeping the public safe requires a combination of high-level protection and high-level comfort. It's why firms have recently developed the next-generation of patented fabric technology used for Soft Body Armor.

Situations can change drastically in just a matter of seconds. Law enforcement officers need to react on instinct. That's why a combination of comfort and protection was made as a priority.

This protection business started from a patented woven fabric technology that helps enable vests to weigh less than those made of other available least advanced technologies, such as the ones deriving from Nylon materials.

The dynamic mechanical properties of the aromatic polyamide fibres, as well as their viscoelastic behaviour, which can be tailored via suitable resin reinforcement, are perfectly adapted to their use in impact-resistant systems for low or high velocities circumstances. As early as the 1970s, this opportunity was rapidly recognized and translated into concrete applications such as protecting the lives of military personnel and then of civilians, as well as shielding vital strategic equipment.

This type of application implies the use of a fairly large variety of materials, reinforced or not, in various forms, exposed to a fairly wide range of threats with different geometrical shapes being directed at the target, with variable dynamic impact profiles in terms of energy and velocity. Rebouillat et al. did a large contribution in that field, [32], [33], [34], [35], [36], [37], [38].

The diversity of components and parameters renders the task of the scientists, the designers and the engineers extremely complex and furthermore, multidisciplinary.

As represented on Figure 12 the multigenerational path started with woven fabric quite early on as mentioned above. Let's imagine the following scenario, which is close to a realistic situation.

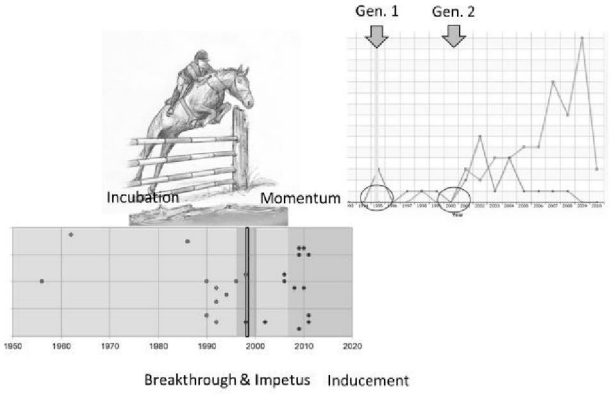

Fig. 12. Boosted Continuous Improvement

Back around 1995 a generation 1, Gen.1, of ballistic resistant laminates was invented by a start-up. Gen. 1 was followed more recently, around year 2000, by a generation 2, Gen.2, based on a multi-axial & multi-layered unidirectional based technology.

Generation 2 was subject to an acquisition by a larger firm.

The most central observation can be made from Figure 12 where the line chart in the upper right corner shows a bimodal distribution of the forward citations, with a large increase after the acquisition of 2000.

This type of technology, although advanced, remains evolutionary rather than revolutionary; one may associate with it the rather balanced forward and backward citation levels, visible on the chart.

The number of patents that this breakthrough, induced or inspired is almost equal to the patents that may have served an incubation role prior to the discovery.

Conclusion 2: open-innovation may boost the technology attractiveness; acquisitions may be favoured versus internal development in terms of development pace.

3- And the Hybrid Vehicles Technology

"Who holds the power?"

The Cie, which started earlier. The same Cie now enjoys a portfolio of patent families representing 43% of the worldwide count. The second in class hold about 15% of the "in kind" patent families; all US car manufacturers 8% and all Euro car manufacturers 7%.

"Cie T has become synonymous with hybrid cars: three out of four hybrid cars sold in the US are made by T. This is no accident. T set out in 1994 to develop hybrid cars and to protect their development with patent filings. T has now sold more than two million hybrid cars."; as Mike Lloyd and Justin Blows explain in GH newsletter.

Figure 7 may represent a behaviour corresponding to the above business approach.

Conclusion 3: start early! The sooner the better…

MAIN CONCLUSION

Our design of an equilibrist's accomplishment and the artistic interpretation performance therewith, depicted on Figure 13, should make the main conclusion brighter than a thousand words.

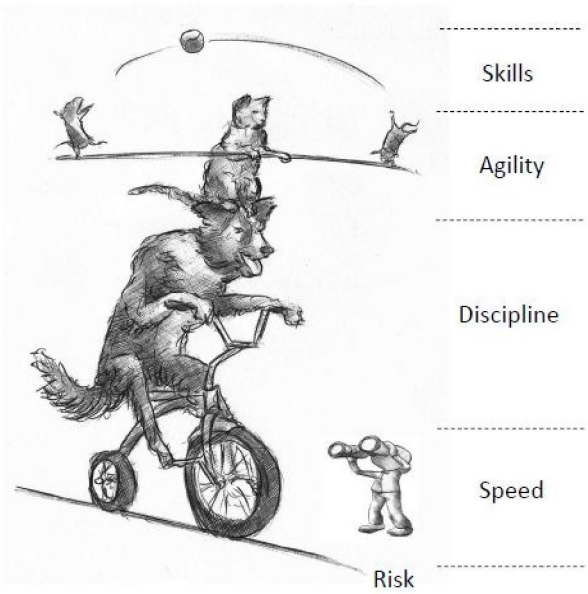

Fig. 13. A Matter of Balance

In a less pictorial fashion, the discipline of adopting a process, such as ATA and the ATA-4C^2© of the author, is essential to the integration of IP and NPL in the business model and roadmaps therewith. The key associated "search" phases are:

- Xpress inventory
- Unexploited assets
- Unexplored areas
- Ideal & dreamed approaches
- Perceived Limitations & Frustrations

Sequences, which involve 8 to 12 participants, 4 hour session repeated 4 times. With a convergence mind-set, this dynamic, involving sufficiently diverse* teams, has proven successful and rather reasonable with regard to dedicated time.

(*) meaning from various business units, of different ages, with different areas of expertise, of different seniority levels, with multiple experiences and from different cultural backgrounds…

ACKNOWLEDGEMENTS

The author thanks:

Benoit Steffenino for his thoughtful comments on figures and outstanding illustrative interpretations of initially technically juvenile draft drawings; those greatly strengthened this work and provide a great entertaining aesthetic.

And Imre Horvath for his stimulus in regard to business model integration; that approach would have hardly exceeded incubation level and may have never materialized, within my IP domain of expertise, without his magic mentoring and his unmatched professional excellence in this field.

REFERENCES

[1] S. Rebouillat, "*The 4C skill balance and the intrapreneur*", 5, 1998, L'actualité Chimique (French Chemical News), Société Chimique de France, ISSN-10 :0151 9093, ISSN-13 : 2105 2409.

[2] P. Anastas, J. Warner, Green Chemistry Theory and Practice, 2000, Oxford University Press, ISBN-10: 0198506988, ISBN-13: 978-0198506980.

[3] V. K. Ahluwalia, M. Kidwai, New trends in green chemistry, 2004, Springer, ISBN 140201872X.

[4] Green Patent Blog, *DuPont: Green Chemistry and Sustainability Efforts in Action*, 2013. [Online] Available: http://www.greenpatentblog.com/2012/08/21/dupont-green-chemistry-and-sustainability-efforts-in-action/ (2013)

[5] B. E. Trusko, International Journal of Innovation Science, ISSN 1757-2223.

[6] J. C. Andre, C. Frochot, "*Problems arising in evaluation of interdisciplinary scientific research for innovation*", International Journal of Innovation Science, 2013, 5, 103.

[7] S. Rebouillat, D. Leclerc, Mathematical Models and Design Methods in Solid-Liquid Separation, NATO ASI Series, Vol. 88, 1985, NATO ASI Series, Ruhston, ISBN: 978-94-010-8751-3.

[8] S. Rebouillat, *"Contribution to the Fundamental Understanding of the Deformation of Porous Media (Contribution à l'étude fondamentale de la déformation de milieux poreux saturés)"*, 2012, INPL Nancy, ISBN : 2-905267-01-1.

[9] P. Le Goff, S. Rebouillat, Energétique industrielle, Volume 3, 1982, Technique and Documentation, Paris, ISBN 2-85206-053-1, ISBN 2-85206 149X.

[10] H. J. Knight, Patent Strategy: For Researchers and Research Managers, 2001, Wiley, ISBN-10: 0471492612, ISBN-13: 978-0471492610.

[11] SIPO, [Online] Available: http://www.ipwatchdog.com/2013/05/07/design-patents-in-china-applications-infringement-and-enforcement/id=40026/

[12] S. Royal, R. Segolene, Editorial Address, ISGC2, Poiters, 2013. [Online] Available: http://isgc2.conference.univ-poitiers.fr/, http://www.isgc2013.com (2013).

[13] J. Tang, "*Patent Miner: topic-driven patent analysis and mining*", Proceeding KDD '12 Proceedings of the 18th ACM SIGKDD international conference on Knowledge discovery and data mining, 2012, 1366-1374, ISBN: 978-1-4503-1462-6.

[14] T. J. Nameroff, R. J. Garant, M. B. Albert, Research Policy, "*Adoption of green chemistry: an analysis based on US patents"*, 2004, 33, 959.

[15] D. M. Kammen, and G. F. Nemet, Issues in Science and Technology, Real Numbers. "*Reversing the incredible shrinking energy R&D budget"*, 2005, 81-88.

[16] S. B. Brunnermeier, M. A. Cohen, Journal of Environmental Economics and Management, "*Determinants of environmental innovation in US manufacturing industries"*, 2003, 45, 278.

[17] K. G. Rivette, D. Kline, M. Blaxill, R. Eckardt, Rembrandts in the Attic: Unlocking the Hidden Value of Patents, 1999, Taking Your Strategy to the Next Level Using Intellectual Property, 2009, ISBN-10: 0875848990, ISBN-13: 978-0875848990, ISBN-10: 1591842379, ISBN-13: 978-1591842378.

[18] C. M. Christensen, The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business, 2011, Harper Business, ISBN-10: 0875848990, ISBN-13: 978-0875848990.

[19] J. Lerner, The American Economic Review, "*The Empirical Impact of Intellectual Property Rights on Innovation: Puzzles and Clues"*, Vol. 99, No. 2, 2009, 99-2, 343. [Online] Available: http://www.jstor.org/stable/25592422 (2009).

[20] Y. Takagi, L. Allman, Mpazi A. Sinjela, Teaching of Intellectual Property: Principles and Methods, 2008, Cambridge University Press, ISBN-10: 0521716462, ISBN-13: 978-0521716468.

[21] J. H. Dyer, Collaborative Advantage: Winning through Extended Enterprise Supplier Networks, 2000, Oxford University Press, ISBN-10: 0195130685, ISBN-13: 978-0195130683.

[22] G. McKibben, Cutting Edge: Gillette's Journey to Global Leadership, 1997, Harvard Business Press, ISBN-10: 0875847250, ISBN-13: 978-0875847252.

[23] D. Tanner, Total Creativity in Business & Industry, 1997, Advanced Practical Thinking Inc, ISBN-10: 0789121948, ISBN-13: 978-0789121943.

[24] J. P. Ficalora, L. Cohen, Quality Function Deployment and Six Sigma, Second Edition: A QFD Handbook, Prentice Hall, 2009, ISBN-10: 0789121948, ISBN-13: 978-0789121943.

[25] T. Pyzdek, P. Keller, The Six Sigma Handbook, 2009, McGraw-Hill Professional; 3rd edition, ISBN-10: 0071623388, ISBN-13: 978-0071623384.
[26] L. Cohen, Quality Function Deployment: How to Make QFD Work for You, 1995, Prentice Hall, ISBN-10: 0201633302, ISBN-13: 978-0201633306.
[27] G. Altshuller, Innovation Algorithm: TRIZ, systematic innovation and technical creativity, 1999, Technical Innovation Ctr, ISBN-10: 0964074044, ISBN-13: 978-0964074040.
[28] A. Osterwalder , Y. Pigneur, J. T. A. Wegberg, Business Model Generation, 2011,Campus Verlag Gmbh, ISBN-10: 359339474X, ISBN-13: 978-3593394749.
[29] S. Rebouillat and F. Pla, Journal of Biomaterials and Nanobiotechnology , "*State of the Art Manufacturing and Engineering of Nanocellulose: A Review of Available Data and Industrial Applications*", 2013, 4, 165, doi: 10.4236/jbnb.2013.42022.
[30] L. Honary, E. Richter, Biobased Lubricants and Greases: Technology and Products, 2011, Wiley, ISBN-10: 0470741589, ISBN-13: 978-0470741580.
[31] S. Rebouillat, M. E. G. Lyons, B. M. P. Doyle and L. Richard, International Journal of Electrochemical Science, "*Paving the Way to the Integration of Smart Nanostructures: Part II: Nanostructured Microdispersed Hydrated Metal Oxides for Electrochemical Energy Conversion and Storage Applications*", 2011, 6, 5830.
[32] S. Rebouillat, J. B. Donnet and T. K. Wang, Polymer ,"Surface Microstructure of a Kevlar® Aramid Fibre Studied by Direct Atomic Force Microscopy," 1997, 38, 2245, doi:10.1016/S0032-3861(96)00768-9.
[33] S. Rebouillat, Journal of Materials Science, "*Tribological Properties of Woven ParaAramid Fabrics and Their Constituent Yarns*", 1998, 33, 3293, doi:10.1023/A:1013225027778.
[34] S. Rebouillat, "Aramids," In: J. W. S. Hearle, Ed., High Performance Fibres, Woodhead Publishing Limited, Sawston, 2001, 23.
[35] S. Rebouillat, et al., Eds., "Carbon Fibers," Marcel Deckert, CRC Press, 1998, ISBN-10: 0824701720, ISBN-13: 978-0824701727.
[36] S. Rebouillat, D. Liksonov and A. Courgey, Journal of Applied Polymer Science, "*New Experimental Device to Test the Dynamic Behavior of Fiber Assemblies and Fibrous Composite Structures with a Focus on Larger Industrial-Scale-Like Samples*", 2012, 123, 1708, doi:10.1002/app.34626.
[37] S. Rebouillat, B. Steffenino and A. Miret-Casas, Journal of Materials Science, "*Aramid, Steel, and Glass: Characterization via Cut Performance Testing, of Composite Knitted Fabrics and Their Constituent Yarns, with a Review of the Art*", 2010, 45, 5378, doi:10.1007/s10853-010-4590-5.
[38] S. Rebouillat, D. Liksonov, Computers & Fluids, "*Fluid-structure interaction in partially filled liquid containers: A comparative review of numerical approaches*", 2010, 39, 739.