The Convoy Model as a new "glocal" growth accelerator metaphor for the economy in the next decade

Apart from a few very successful clusters around the world, most STP's struggle with developing companies into international growth companies. Possible explanations could be lack of the necessary potential within the companies, lack of necessary assistance to prompt gazelle growth and secure internationalisation or unstable or unpredictable markets. This session will explore best practice in accelerating growth in high tech companies.

Executive Summary

For some 20 years, regional and city based innovation and economic development policy focused on clustering, based on Michael Porter's (1990) Competitive Advantage of Nations. However, there are still those who are doubtful about whether clusters foster economic development.

In this article an alternative is proposed: the convoy model. The evidence that clusters lead to successful inter-firm regional interaction is inconclusive. Is it time for a rethink?

In the current economic climate, and bearing in mind the importance of creating new models to foster the competitiveness of our SME, it is necessary to redefine the model that has been widely implemented, i.e. the Cluster Model. We need a new model that will become the metaphor for accelerated and new economic, technological and societal growth in the decade to 2020.

Convoy is a more powerful metaphor than cluster to describe a local economic development strategy and is worthy of equal attention.

Companies growth in high-technology environments: landscape

The growth stage often requires major changes in entrepreneurial strategy[1] . Competition and other market forces call for the reformulation of strategies. Due to the rising of new and more substantial problems than those the entrepreneur faces during the start-up stage, a reorientation of the type of leadership: from entrepreneurial one-person to managerial team-oriented, is required.

The building of more dynamic capabilities for getting differentiation from emerging competitor is an interesting challenge for growing firms. The movement to globalization and more to "glocalization" concept (thinking in global but acting locally) requires also re-examination of companies on their culture, structure and systems to be adapted to the new challenges. Now it is the time to bring up essential elements such as innovation and entrepreneurial thinking in strategies of growing ventures.

Thus, the transition from an entrepreneurial style to a managerial approach makes a difference in the business growth process. The new management approach will help to embed the company in a richer environment, where different disciplines converge in a common work streamlined with specific flexible methodology that will be adapted to the dynamic change requirements to generate extreme innovation (Xtrevation)

If we rely on the extended Ansoff Growth matrix which helps to decide business strategy in terms of products and market growth, we want to focus on three specific strategies related to the interaction between the company and new markets: Product development, Diversification and High technology.

1 "Entrepreneurships Theory, Process & Practice" Donald F. Kuratko

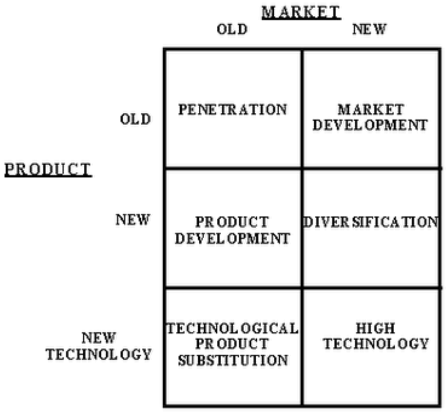


Fig.1 Extended Ansoff Growth matrix (Source: Zulfan Rauhandi, 2010)

On the one hand, **Product development** is the name given to a growth strategy where a business aims to introduce new products into existing markets. This strategy requires the achievement of new competencies and a deep analysis of the target markets to ensure that the product will be accepted successfully by the user.

On the other hand, **Diversification** is the name given to the growth strategy where a business markets new products in new markets. Obviously, the risk inherent to the strategy is much higher than other scenarios, mainly because the business uses to have little or no experience in those new markets.

For a business to adopt a diversification strategy, it must therefore have a clear idea about what it expects to gain from the strategy and an honest assessment of the risks.

Finally, a very important aspect of growing strategy is the **introduction of new technology products**[2] into new markets. In order to achieve success during the process of introduction we should consider the three main steps to be performed:

- To understand the customer needs
- To educate the customer about the product and technology underlying
- To convince the customer that the new product is the best solution to their problems (in some cases the problem is new and in the other it is not even considered)

Once we have a clear idea of the main features related to growth ventures, a necessity to identify mechanisms to foster the business growth, and thus region wealth growth, starts to arise.

Michael E. Porter introduced the notion of cluster an agglomeration of closely related industries[3]. It will be one of the two countervailing economic forces that will be taken an important role later on region-industry performance growth[4] .

2 "Growth strategies for High Tech Firms", Zulfan Rauhandi, http://zulfanrauhandi.blogspot.com/2010/07/growth-strategies-for-high-tech-firms.html
3 "Clusters and entrepreneurship" Delgado, M., Porter, M. E., Stern, S. (2010)
4 "Clusters, convergence and economic performance". Delgado, M., Porter, M. E., Stern, S. (2007)

Cluster model perspective

The notion of cluster to refer to business and economic environments has been around since the beginning of the 1990s, since Porter's (1990**) The Competitive Advantage of Nations**, but the underlying concept of agglomeration economies was familiar to economists as early as the 1890s, when it was evident in the work of Alfred Marshall.

The cluster, defined as a *'geographic concentration of business initiatives, suppliers and associated institutions in a particular field'* has played an important role in enhancing firms' productivity. Clusters have enabled member firms to achieve important competitive edge in national and international markets.

Porter eventually opted for the Cluster model as a key to promoting innovation in the target sector or stimulating new business initiatives and with this vision a myriad of clusters have been created in diverse areas of expertise: biotechnology, ICT, health, environment, etc. scattered geographically on the basis of the different values of each of them.

First, Porter[5] often provides a list of elements in a cluster but can be condensed in four factors[6]:

1. Firms of a similar industry, its strategy and rivalry.
2. Supply conditions (such as suppliers and extending to legal, technological, and consulting services).
3. Demand conditions (such as core customers).
4. Related and supporting industries that include the rest of the list—from governments and universities to trade associations and experienced capital (i.e., venture capital).

The second aspect of the cluster is its interconnectedness[7], the linkage among these elements. Porter[5] emphasizes that collaboration and competition among them can promote growth, innovation, and competitiveness. According to Porter, this is a consequence of:

1. Increasing the productivity of companies.
2. Driving the direction and pace of innovation.
3. Stimulating the formation of new businesses.

An example of one of the most important clusters is Silicon Valley in California, established in the 1990s on the basis of a group of technology companies that attracted venture capital investment and other companies. The partnerships forged (**cross pollination**) have generated new business initiatives.

Another example is the tile cluster in the province of Castellón in Spain (referred to by Porter as an example of a cluster able to compete with Sassuolo in Italy and Santa Caterina in Brazil), which is analysed by the Jordan Competitiveness Team[8]. Currently, the Castellón tile and ceramic cluster in Spain has been greatly affected by the global financial crisis, which has led many companies to close or be restructured. The atomized structure of the cluster meant that the main focus was on production, with marketing, distribution and processes having less interest. However, this focus needs to be changed to create new business opportunities to compete against low cost resources and production in Asia.

Bearing in mind Clusters' main characteristics, we may reflect on some behaviors:

- They are static elements, capable of growing by approximation. That is, entrepreneurs are dropped off on Clusters, in their particular sector, in order to "**absorb the aroma of innovation**

5 "Clusters and the new economics of competition". Harvard Business Review, 76(6), 77-90. Porter, M. E. (1998).
6 "Location, competition, and economic develop- ment: Local clusters in a global economy" Economic Development Quarterly, Porter, M. E. (2000).
7 "What Was New About The Cluster Theory?". Yasuyuki Montoyama, 2008.
8 "Cluster-based policies" The Cluster Competitiveness Group, S.A. Technology Park Valles, 2002 http://www.competitiveness.gov.jo/files/What_Cluster.pdf

environment". In many cases, firms join clusters in the hope that this will generate new business, in most cases by serendipity.

- Clusters are focused on specific products or services and knowledge areas aligned to their location's economic and industrial needs. As Ketels[9] states: '*The necessary condition for any kind of empirical work on Clusters is to find a consistent definition of what economic activities belong or should belong to the cluster'*.

- The movement that businesses follow when they land in a Cluster belonging to their sector is rather "**Brownian**", ie without prior planning and spinning around looking for business opportunities.

Ketels also suggests that a cluster location increases the efficiency and effectiveness of cluster firms. Cluster location may mean that financial investment generates greater economic value than their opportunity costs.

Another aspect to keep in mind is the sustainability of a cluster once the initial phase has finished (when more support is needed) and indeed, creating a cluster is a long-term process which means that the final cost could be higher than expected.

Leaving aside the different perspectives about the Porter's Cluster Model efficiency, marked by several authors in terms of the process of emerging clusters or how the model could be repeatable in other scenarios with success, we have been searching alternatives or improvements to current model, in order to foster the innovation, accelerate the impact achieved of a project and strengthening the productivity of the processes involved.

By good fortune, we met a very special person, Prof G. Mensch[10] with a very unique idea that we are comprehensively developing altogether. Prof. Mensch put forward a new concept: "**The Convoy Model"**. This new concept could become a revolution in the innovation arena in front of the former Porter's Cluster Model.

What is the "Convoy Model"?

The Convoy Model[11] [12] is a new approach to the region-industry innovation generation, and an improved alternative to Porter's Cluster Model, which aims to be built over three main cornerstones:

- It is multidisciplinary and multi-synergic, as it allows the involvement of different agents (companies, institutions, governments, customers, providers and citizens) by means of "interactions" (out-in), "outreactions" (in-out) and coopetition relationships (cooperating + competing).

- It stimulates and reinforces the Open Innovation actions.

- It is a MIMO (Multi-input Multi-ouput) entity.

9 "The Development of the cluster concept - present experiences and Further Developments" (2003)

10 Wikipedia, http://de.wikipedia.org/wiki/Gerhard_Mensch_(Innovationsforscher)

11 "The Inspection Problem", G.O. Mensch, Working Paper No. 241, CRMS Center for Research in Management Science, University of California, Berkeley, January 1968,

12 "On Integral Complementarity", G.O. Mensch,Working Paper No. 245, CRMS Center for Research in Management Science, Berkeley, February 1968; both papers solve the governance and coordination problems of "moving in sync" and provide the mathematical proof (Kuhn-Tucker conditions) of Existence Theorem of "movements in convoy").

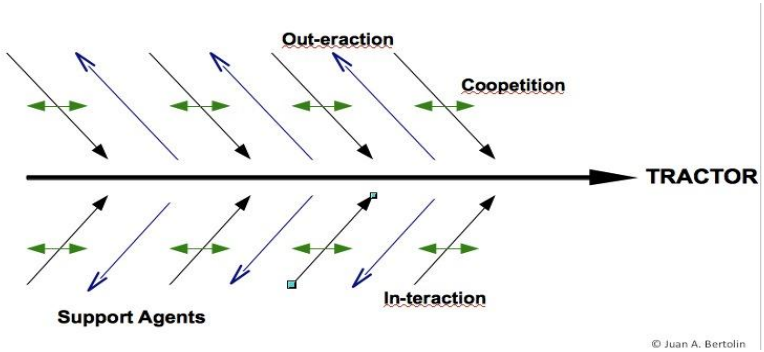


Fig.2 Fish-bone of tractor projects (proprietary development)

The Convoy Model is dynamic compared to Porter's static cluster model; it is planned rather than evolving. It acts as a magnet attracting collaboration and initiatives that enable continuous improvement, continuous value creation, and synergies.

The **Convoy Model** drives the elements in the innovation ecosystem via its main entity: the tractor.

The Convoy Model can be considered as providing the motion in a cluster: all the positive economic impacts highlighted by Porter (new jobs, economic wealth, etc.) also apply to this new model. In other words, we would agree that the co-location of companies, customers, suppliers and others institutions increases the perception of innovation opportunities while amplifying the pressure for innovation[13].

However, these effects are amplified in the **Convoy Model**, since the group's entrepreneurial activity is focused on the needs of the 'tractor' project.

The Convoy Model can be used to regenerate traditional sectors and traditional management techniques, which have been unable to adapt to the future.

Tractor as the keystone entity of the Convoy Model

As has already been mentioned, the **Convoy Model** relies on a key entity **'the tractor'**. But what is "**the tractor**" of a project?

The **tractor** is the driving unit of a project, that pulls in one direction the co-location of related satellite agents around it, and which will interact among them from inside to outside and vice versa. For instance, it will be similar to a consolidated and strongly innovative company that, once established, attracts other companies to be located close to it in order to take advantage of the proximity when tackling a project. These satellite companies may belong to other sectors and disciplines and be engaged in activities related to the company's main mission. Co-location of these companies encourages coopetiting working (cooperating + competing) towards a common target.

The **Convoy Model** does not relate to a specific sector. It can be likened to an articulated vehicle whose total weight is driven by the traction element (tractor), also called the "**locomotive**" of the convoy, and it is crucial to identify how many "locomotives" of the convoy we do have (bearing in mind its MIMO 'Multi-Input, Multi-output' nature).

The traction motion of a Convoy Project surfaces two powerful effects:

- **Cross-pollination** among the agents and entities involved is also inherited from the Cluster

13 "Location, competition, and economic develop- ment: Local clusters in a global economy" Economic Development Quarterly, Porter, M. E. (2000).

Model.

- **Social Capital generation**[14], as a consequence of the knowledge and information exchange among all the project participants.

Keystones of the Convoy Model

We have identified a set of elements that conform what we call the "**Octagonal Innovation Ecosystem**" which could be considered as the vital elements to develop projects under the Convoy Model and that will determine the traction motion process.

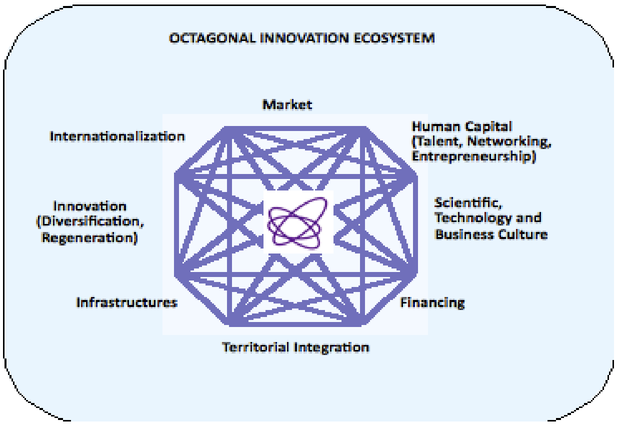


Fig.3 Octagonal Innovation Ecosystem (proprietary development)

The Octagonal Innovation Ecosystem is an evolved version of the Silicon Valley ecosystem of innovation developed by Tapan Munroe and Mark Westwind[15] and tries to cover the most relevant strategic axes or cornerstones in the management of a Science and Technology Park. All the elements are interconnected because of the inherent relationship among them. The same elements can be applied to whichever project led by the STP.

How to manage a Convoy Project?

The project management methodology is crucial in the context of this complex new model and requires a new perspective. Projects are not implemented just to respond to user requirements; they must be capable of ongoing adaptation to changing requirements and new products, also known as "evolutionary project management". The final goal may be different from the initial target based on initial user requirements. This requires flexibility, a new project management paradigm and a **HIST (High Impact, Short Time)** philosophy, that is to say projects performed based on continual feedback.

The theoretical basis of this sort of "evolutionary" project management is complexity theory applied to complex realities when knowledge is lacking and available information is imperfect, and uncertain. These deficiencies are viewed as opportunities for innovative actions. "**Evolutionary**" project management works with inventions and visions of possibilities, and scenarios about an "augmented reality".

14 "Intra-organizational social capital in business organizations: A theoretical model with a focus on servant leadership as antecedent", Pablo Ruíz, Ricardo Martínez, Job Rodrigo, Ramon Llull Journal of Applied Ethics,(2010)

15 "Silicon Valley: The Ecology of Innovation", Tapan Munroe, Mark Westwind, (2008) ISBN: 8461272579

The differences between "actual reality" and "augmented realities" form the "opportunity landscape" where conjectures about the good opportunities for innovative initiatives guide the planning and execution of projects.

Viewed in this way, the "Art of Innovating" is finding a middleground between overcomplicating and oversimplifying the potential, and in designing a road map for the project work while the intially vague "opportunity landscape" gets clearer as we go ahead.

Convoy Projects embed complexity in society, economics and technology, and traditional project management can not therefore be used here; instead, a set of new challenges and requirements are bringing up in this kind of special projects where dynamics of instability[16] are present.

In general, every Convoy project will be different due to the variety of existing approaches, but they all should be treated as similar in essence. Nevertheless, quantifying all the Convoy characteristics related to its uncertainty is required and the appropriate measures, if needed, must be taken.

Project uncertainty is a very important challenge in the management of today's projects, and even more in those ones where user requirements are changing along time (in some way because of new functionalities required by the user and in some way because of the feedback from the results of its execution). The **Project Management Institute's A Guide to the Project Management Body of Knowledge - fourth edition (PMI, 2008)-** describes uncertainty as risk conditions, aspects of the project or organization's environment that increase project risk. The risk of failing to meet schedule, cost or performance goals is what makes uncertainty threatening.

It is not worthless to say, that this sort of complexity in Convoy Projects Management implies a strong focus on the design of an effective and efficient **Risk Mitigation Plan**, in order to assess all the potential combinations of possible solutions or results of the interactions, in such a way that we will be able to get the BDT (Best Decision Taken) when a problems arises.

Ohtaka and Fukazawa[17] have developed a very interesting model (**Cyclic Casual Model**) that contributes to facilitate the recognition of **Serious problem projects (SPPs)** empirically and help to manage risk symptom. We are planning to incorporate this model to Convoy Projects Risk Management.

That's the case of Convoy Projects whose approach is closer to **Predictive Adaptive Models**:

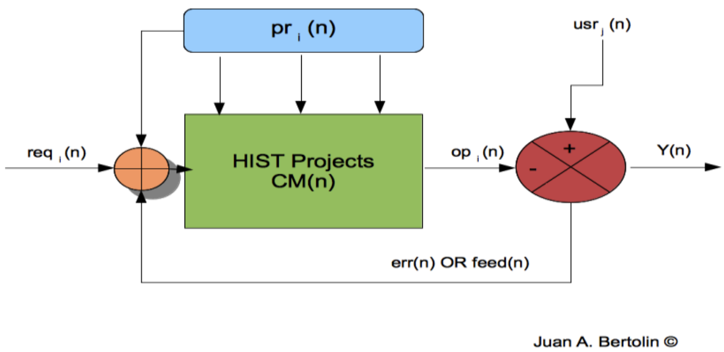


Fig.4 Predictive-adaptive schema of Convoy Models (proprietary development)

16 "Beyond Frontiers of Traditional Project Management: An Approach to Evolutionary, Self-Organizational Principles and the Complexity Theory", Manfred Saynisch, Project Management Journal, PMI (April 2010)

17 "Managing Risk Symptom: A Method to Identify Major Risks of Serious Problem Projects in SI Environment Using Cyclic Casual Model", Hirosgi Ohtaka, Yoshiaki Fukazawa. Project Management Journal, PMI (March 2010)

where:

req $_i$ (n) is the set of initial and ongoing requirements, from i=0 to N, that will feed the CM (n) or convoy model functionality and will vary depending on the results of the feedback from the interaction: op i (n) and usr j (n)

CM(n) is the Transfer function of the Convoy Model project and defines its behavior based on input data (initial requirements and perturbations).

pr $_i$ (n) is the perturbation function. This function can not be modified so the transfer function CM (n) should predict the perturbations and modify its behavior based on the output results too.

usr $_j$ (n) is the interaction (from j=0 to M) of the user over the results of the process CM (n) (also known as user pattern function)

op $_i$ (n) is the "Output result" from the Transfer function and the perturbations over the system = CM(n)*pr i (n)

err(n) OR feed(n) is a logical OR operation where the errors detected by the user or additional feedback provided by the user to improve the output result of the process CM (n) aggregate.

Y(n) is the **output final function** once the system behavior has been adapted and corrected.

Impact of Convoy Model on Innovation Generation

One of the main questions that could come up when implementing new models of innovation is how to measure their impact on regional performance.

Porter[18] demonstrated that strong cluster environment surrounding a particular region-industry enhanced growth at the region-industry level through increasing efficiency, driving productivity and job creation, and increasing returns to expansion, investment, and innovation. Indeed another element that contributed to the innovation generation was spillovers between a regional industry and strong clusters present in nearby regions.

The Convoy Model is a special case of Porter's clusters from the dynamic motional perspective, so the same key performance indicators (KPI) should be considered as applicable in order to measure their impact on the region. However, the Convoy Model incorporates some additional elements that will reinforce its economic results:

- One is the **power of complex networks** developed as a consequence of the multiple interactions among all the agents and entities.
- The other element is the **reduced time-to-market of added-value deliverables produced**.

The philosophy of this sort of projects delivers high-impact results in a very short term (HIST), as a consequence of the fast-performing methodology that will help to increase the productivity of the resources used to build up Convoy projects.

Although there are several mechanisms to forecast and measure innovation performance, in these kind of projects, there is one particularly interesting: by means of **neural networks approach**[19], that we are going to apply to demonstrate the high-level of innovation generation produced by Convoy Projects under this current model. The technique was applied by the Department of

18 "Clusters, convergence and economic performance". Delgado, M., Porter, M. E., Stern, S. (2007)

19 "Forecasting innovation performace via neural networks - a case of Taiwanese manufacturing industry", Tai-Yue Wang, Shih-Chien Chien (2006)

Industrial and Information Management from the National Cheng Kung University of Taiwan and it is perfectly extrapolable to Convoy Model projects.

Convoy Model Landing at STPs: Soft or Hard?

Once we have defined the Convoy Model landscape, the first question that could be brought up is:

How could Convoy Model be used in Science and Technology Parks (STP)?

Let's start remembering the definition of Science and Technology Park, provided by IASP (2002):

"A Science Park is an organisation managed by specialised professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions.

To enable these goals to be met, a Science Park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high quality space and facilities. "

Bearing in mind the strengthen of the concept: "Convoy Model" and the powerful capabilities of a Science and Technology Park, we would rather to extend the definition adding the following feature:

"A Science and Technology Park should be able to identify and co-lead tractor projects involving all the agents and entities belonging to the Octagonal Ecosystem of Innovation with the main purpose of generating wealth in the region and easing the adequate mechanisms to ensure the success achievement of the SMEs"

STP become a very interesting scenario in which Convoy Projects could be placed and due to several reasons:

- STP are environments where IT is straightforward to develop and maintain relationships with other organizations. These interactions ease the access to key resources, information, markets, technologies, advantages from knowledge and learning, scale and scope economies, as well as risk sharing[20].
- STP create a physical landscape that enables economic agent's interaction within the same geographical area[20]. We consider that the relations between firms and Universities can generate valuable organizational social capital[21].
- STP are an artificial physical structure that also facilitates interaction among the economic

20 "Strategic networks", Gulati, Nohria & Zaheer, 2000, Strategic Management Journal, 2000

21 "Social Capital Generation Inside Science Parks: An Analysis Of Business-University Relationships",Martínez-Cañas, R. y Ruiz-Palomino, P. (2010): International Journal of Management & Information Systems, Volumen 14, Numero 4, pp. 45-50.

agents located inside[22].

- STP is a magnet for heavy investment in technology. A park attracts business dedicated to applying innovative technology[23].

This fact can help researchers to explain why and how organizations connect effectively, work cooperatively and coordinate their activities to achieve a superior performance in the market.
Due to the nature of the STP environment, Convoy Projects will enhance the ability of the companies involved in the project, to develop new products and bring them to the market with high success rates. The knowledge that firms can derive from their relationships may be particularly valuable for the development of new products and services[24],

In order to be able to answer the question about: how new tractors emerge, some actions have to be taken:

- Creation a "thinkubator" structure to set up an appropriate environment for the generation of new ideas, determination of main goal of the project and identification of agents and entities to be involved.
- Once designed, it can be implemented in the very short term based on “evolutionary project management” approach and using the appropriate mechanisms to put it on place.

We are going to briefly mention two tractor projects launched at espaitec Science and Technology Park, not as case studies but as Convoy Model samples.

Convoy Model for e'Living Lab Tractor Project

Living Lab is a user co-creation technique based on crowdsourcing. The Living Lab concept originates from MIT, Boston and represents a user-centric research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts[25].

Living Lab is a good example of a Convoy Model where decisions are made about specific goals and their achievement is supported by numerous agents in a ‘fish-bone’ structure as the one already depicted at the beginning of the paper.

The implementation of the Living Lab is based on the involvement of the user (firms, organizations and consumers) in the innovation process.

At espaitec, Science and Technology Park of Castellon, we are developing a Living Lab (called e'Living Lab) located at the University Campus and open to the rest of the citizens of Castellon to participate in co-creating products and services, prototyping and validating them in several technology fields: biotechnology, robotics, Machine-to-machine communication and automatisms among others.

Through open collaboration between a large variety of participants (main step to generate open innovation), e'Living Lab does not favor any specific technology but rather focus on fostering inter-collaboration among all of them and capturing the values of technology based on the usefulness that it bring.

22 “Science Parks as Knowledge Organizations: The "Ba" In Action?” Hansson, F. (2007): European Journal of Innovation Management, 10 (3), 348-366.

23 “Success factors in Science and Technology Parks” Hodgson, B (1994). En Scheifler Mª A. Los Parques Científicos. Principales Experiencias Internacionales, Ed. Civitas, Madrid

24 “The Sources of Innovation”, Erick von Hippel, Oxford University Press (1988)

25 “State-of-the-art in utilizing Living Labs approach to user-centric ICT innovation – a European Approach.”, Mats Eriksson, Veli-Pekka Niitamo and Seija Kulkki.. (2005)

Convoy Model for BioPharma Tractor Project

This is another example, not as a case study because it is still running. The project started in 2010 at the espaitec, Science and Technology Park of Castellon. The project's goal was helping the innovating company, Mensch Biopharma, in designing and in constructing an innovative phytopharma factory in the Castellon area.

The biopharma product innovation is a natural medicine (medicinal herb) that requires application and hybrid integration of brand new green biotechnology in the selection of medicinal plants, and the application of proprietary plant bioinformatics in the selection and prototyping of plant varieties, and their testing for biomedical efficacy.

The key point is that tractor project managers need the Convoy Model for steering the efforts at higher validity and reliability, and the innovator-entrepreneur needs the technical project management skills that characterize a tractor project. It works both ways when it works. In other words, if successful, the "evolutionary" project not only integrates several converging technologies at the material level of the project, it also integrates two governance tools at the leadership level of the project.

In our example of evolutionary planning of the Mensch Biopharma phytopharmaceutical production facilities, the set of final specs includes three "chunks": Integrating new green biotechnology of medicinal herbs with life science soil bioinformatics that is the platform for harvesting the natural drug material, on one side, and the processing, quality testing and packaging the natural drug, on the other side of the supply chain, plus, thirdly, the rational integration of all that complexity with the convoy model. So that the fully integrated Enterprise Resource System and the fully integrated Customer Relationship System work seamlessly hand in hand.

The project is "evolutionary" in the sense that like in any innovation project, the initial set of specifications of the desired output of the innovation process is vague. This vagueness is directly proportional to the initial lack of specific knowledge (validity) and the lack of confidence in the initial knowledge (reliability).

What adds to this initial vagueness is an organizational uncertainty that stems from a double-bind situation most innovation financiers (private as well as public) find themselves in: Their innovation fonds investors want two contradictory things at the same time; they want risk reduction, on the one hand, thus forcing investees to formulate prudent and conservative initial specs, making the project less interesting. And, on the other hand, these investors desire an increased upside potential from the innovation project, forcing investees to formulate overly ambitious sets of initial specs, thus lowering the probability of success of the innovation project.

This is the basic dilemma of all innovators.

And there are two issues that make the basic dilemma more complicated: If the innovation is a major innovation (and not just a minor one), it tends to pull-in additional uncertainties from unexpected side lines. For example, the trans-rapid was delayed years and years because each time something went wrong, it was some supplier's conventional part that worked well in traditional jobs but failed when inserted into the innovational context where its initial validity and reliability assumptions proved wrong.

In short, this happens when the project is so attractive, and has so much traction (pull power), that it qualifies as a tractor project that has the potential of bringing-in a major innovation. And in order to maximize the up-side potential over and above the initial "safe" specs, the shareholders and the stakeholders of the project must govern all work to move in convoy (value-directed push and pull).

This basic dilemma invites to state the key point in "evolutionary" project management: As everyone is interested in improving the set of initial specifications to meet higher goals in the end than appeared permissible at the start, the issues of uncertainty, lack of initial know-how, know-what and what-not (validity, reliability) must be addressed strategically, at the beginning of the planning process.

Before digging deeper into "evolutionary" project management, let us differentiate further. For example, let us separate notions of evolutionary from notions of revolutionary. When in February 2011 US President Barack Obama was referring to the challenges ahead in the innovation field, calling it an actual "Sputnik" challenge, he was referring to the Kennedy time, when initially, in 1961, the national goal was formulated as "going to the moon". That was "vague" enough for the time. For some, it meant sending an Apollo rocket so far up that the space vehicle would fly beyond the moon and disappear in outer space. For others, it meant that the space craft would circle the moon once and then return to earth, where it would go up in flames and evaporate when re-entering the earth's atmosphere.

Over and above the "un-manned" versions, the "manned" versions of the Apollo project clearly became a "revolutionary" project; and it took the professionals at least a year until they were able to formulate a more ambitious initial set of specifications that would fit the ultimate goal: "To set foot on the moon and bring the astronauts back home alive".

In this paper, our tractor project is "evolutionary" and certainly not "revolutionary". And we can precisely state the "convoy conditions" for success on a more modest level of aspiration (A) versus a more ambitious level of aspiration (B), and we can estimate costs and revenues.

Thus we shall concentrate upon the planning stage of evolutionary project management and set aside details about the execution phase, although in practice the phases overlap when initial goals are being set higher and higher as "forward learning" permits.

The practical case example presented here prompts us to differentiate levels of ambitions for the set of provisionally adopted final specifications that say with validity and reliability, for example, most ambitiously, how to "bring the astronauts back home alive".

Facit: Evolutionary product management can make value-adding contributions to quality of life and to more income and growth.

Conclusions

This paper does not aim to be a case study of different examples of Convoy Projects when applying the model, but a working case paper and a alive reflection about how new models of innovation generation can foster the economy in a region (that should be the main goal of any Science and Technology Park), and above all how Science and Technology Parks can play an active role as a tractor entity of those projects as well .

Convoy Model poses the value-added by reinforcing the fact that hybridization (on all its forms and shapes) is the key for generating extreme innovation (**Xtrevation**) and, thus, for the creation of wealth in the region.

Samples like the Living Labs developed at espaitec or BioPharma Tractor Project, introduced in this paper, are just examples about how a innovative philosophy of hybridizing agents, entities, industries and knowledge can be successful when developing a strategy to achieve a goal. These projects are still in developing phase so we expect to get some results in a short term.

But, as Peter Drucker already stated: “**If you can't measure it, you can't manage it**”, that is to say: it is crucial to develop techniques that allow us to measure the impact of innovative methodologies. In these type of high-complexity projects, the measurement of efficiency and results is not easy due to the large number of variables and uncertainty managed, nevertheless we discovered that tools like **Neural Networks** are suitable mathematical models to forecast and assess the innovation performance in these cases. We could find others though.

Annex I: Methodological Foundation of Evolutionary Tractor Project Management

Nonlinear Dynamic Complexity Theory – Basis for the Evolutionary Approach

The theoretical basis of "evolutionary" project management is complexity theory applied to complex realities when knowledge is lacking and available information is imperfect, and uncertain. These deficiencies are viewed as opportunities for bold innovative actions that require “forward learning” to find and seize the opportunities. In the cases of “major” innovations, such forward learning is double-complicated as it attracts other innovators and pulls other innovations along for the better or the worse.

Such “major innovation” projects typically turn into “Evolutionary Tractor Projects”.

This contingency requires “forward learning” not only in “actual reality” but also in an “augmented reality” as the actuality changes (transforms) faster and faster. Typically both the content of an “actual” reality can change fast, and the context morphs. This dual complexity calls for a nonlinear dynamical programming methodology for the planning stage of such projects. This is explained in the subsequent section.

"Evolutionary" project management works with technological inventions and visions of commercial possibilities, and with scenarios about an "augmented reality".

The differences between "actual reality" and "augmented realities" form the so-called "opportunity landscape" where conjectures about the good or great opportunities for innovative initiatives guide the planning and execution of projects. In the next section entitled “coping with complexity of contents and contexts” we delineate a complexity theoretical framework for structuring the business model and for strategizing about “Doing the right things” and about “Doing things right” without getting overwhelmed by too much complexity.

Viewed in this way, the "Art of Innovating" boils down to finding a middleground between overcomplicating the context for worthwhile actions and oversimplifying the innovation potential and missing the best opportunities. In a nutshell, the core competency in evolutionary project planning is designing a road map for the project work that morphs the intially vague "opportunity landscape" into a successively clearer innovation potential as the innovations team moves on. What Kenneth Arrow some 60 years ago called “Learning by Doing” in a (neoclassical) Walras Economy with mostly homogeneous goods and little or no innovation and entrepreneurship is now conceived as “Forward Learning” in an (evolutionary) Schumpeter Economy with more and major innovations that require an evolutionary Microfoundation. In the following two sections “coping with complexity” and “mathematical basis of the convoy model” we delineate Strategy-Structure-Steering-Performance aspects of such a Microfoundation that’s consistent with evolutionary Management Science.

Evolutionary tractor project management is a challenge for management science.

One challenge is to find an economically sustainable mix of complex vs. simple.

As an example for such middleground, it is often said that one bird in the hand is better than three birds in the bush. By the same token, the gist of "evolutionary" project management is to recognize complexity by its two most prominent characteristics, namely, chaos versus partial order, and to look for enough complexity, but not too much and not too little, for finding safe grounds for forming a business structure and formulating the business strategy. In the following section, we illustrate this approach by looking at some graphs of various degrees of complexity expressed by the most outstanding features of regularity in complexity: "Unity" and "Symmetry". These features help the hunter to catch one bird at a time and not to get side-tracked by the birds in the bushes.

Typically, major innovations require that a "bunch" of innovators move in convoy, and synchronize their steps, moving "in synch".

This is the core of Mensch's Convoy Model of motion in space and time, and finding opportunities for entrepreneurial innovations.

Originally, Gerhard Mensch conceived of the The Convoy Model in his doctoral work on job-shop scheduling, which deals with given jobs and perfect information. Later, in Stanford and Berkeley, he extended this scientific work on "moving in synch" to some Silicon Valley innovation processes where "jobs" are defined as overcoming "lack of knowledge" when information is scarce or impossible to find under the space-time circumstances. This is the special relativity theory of innovation on two levels, on the leadership level and the division of labor level (see G.O. Mensch, "The Inspection Problem", Working Paper No. 241, CRMS Center for Research in Management Science, University of California, Berkeley, January 1968, and Mensch, "On Integral Complementarity", Working Paper No. 245, CRMS Center for Research in Management Science, Berkeley, February 1968; both papers solve the governance and coordination problems of "moving in sync" and provide the mathematical proof (Kuhn-Tucker conditions) of Existence Theorem of "movements in convoy").

Just like a picture says more than a thousand words, and like a song can paint one thousand pictures in one's imagination, there is a great benefit in presenting the complexity of an "opportunity landscape" graphically, using the two wholistic features "Unity" and "Symmetry" as ways to show different degrees of complexity. In our brains, these features represent memories, and "chunks of knowledge". Finding such “chunks” by organizing forward learning is the evolutionary “Function of the Executive”. The mathematical basis of this Microfoundation and Management Science orientation is being defined at the end of this part of the paper. In a nutshell, it operationalizes evolutionary opportunities in a nonlinear dynamical programming framework for evolutionary tractor project management. In short, it helps achieving in the Strategy-Structure (S-S) and Steering-Performance (S-P) management policy framework what Ken Andrews suggested: Learning of "Doing the right thing" and Learning of "Doing things right" in the Planning and Execution of Tractor Projects.

Coping with Complex Contents and Contexts

by Gerhard O. Mensch, at www.GOMensch.com

Too much complexity is overwhelming. Miller's magical number $N = 7 +/- 2$ means that we all have limited brain space to pack things into one's individual neuronal network. And *output of team work* in complex innovation processes tends towards below the low ($N < 5$) instead of going beyond the high ($N > 9$), if the team work is not assisted by good information processing and by project management that's evolutionary as it implements methods of forward learning for the practical purpose of achieving goals that tend to N=10 rather than N=5.

This essay on forward learning in coping with complexity in dynamic systems maintains: (A) We can begin studying the "Opportunity Landscape" by
(B) applications of evolutionary project management that is
(C) based upon mathematical methods for forward learning,
and it shows how we can gain insights into the co-evolution of complex innovation processes and complex changes in the context of opportunity landscapes by
(D) varying the number N systematically, at the low and high end,
(E) and use the wholistic features of "Unity" and "Symmetry" for
the purpose of "chunking" hidden knowledge that is implicit in any opportunity landscape, and *can be made explicit and practically usable by forward learning*.

The explicit mathematics takes space. Hence, we'll vary $0<N<20$ graphically in the following two assemblies of plots, denoted Assembly 1 and Assembly 2.

Both the Assembly 1 and the Assembly 2 employ the concept of the unit circle for assembling points into a ("simplistic") subset of low Ns that are easily seen and integrated into a "chunk of points located on the circle" even by the kids in Kindergarden, on the one hand, and into a ("complicated") subset of highter Ns that are located in the circle, where they form patterns, on the other hand. What matters is the "golden" proportionality between the revealed patterns.

By varying N from 1 to 20 and plotting the solutions of the PPP = Point Packing Problem by 1. allocating the lower Ns on the circle and 2. solving for maximal density of points relative to minimum distances between points, the two assemblies emerge and patterns become visible. The plots depict a hidden wealth of the implicit knowledge embedded in both the "chunks on the circle" and the "chunks within the circle", and also in the existing pattern proportionality.

"In teaching forward learning in innovations management classes, and in advising innovation teams in companies, I love to show case N=19. It shows the beauty of form follows function in *terms of symmetry and proportions between the outer and inner unities*" (...GOMensch.com).

Assembly 1: Projecting Complexity upon a Circle

The Plots of Points show Pattern Proportions in the solutions for N from 2 to 20 for the PPP= Point Packing Problem. The analogy is that our brain's capacity to cope with complexity has, on one hand, individual limits on volume/variety, expressed by Miller as a "magical number" N = 7 +/-2. And this "*quantitative*" issue of Volume versus Variety can be addressed by some "packing" algorithm like PPP if N is changed.

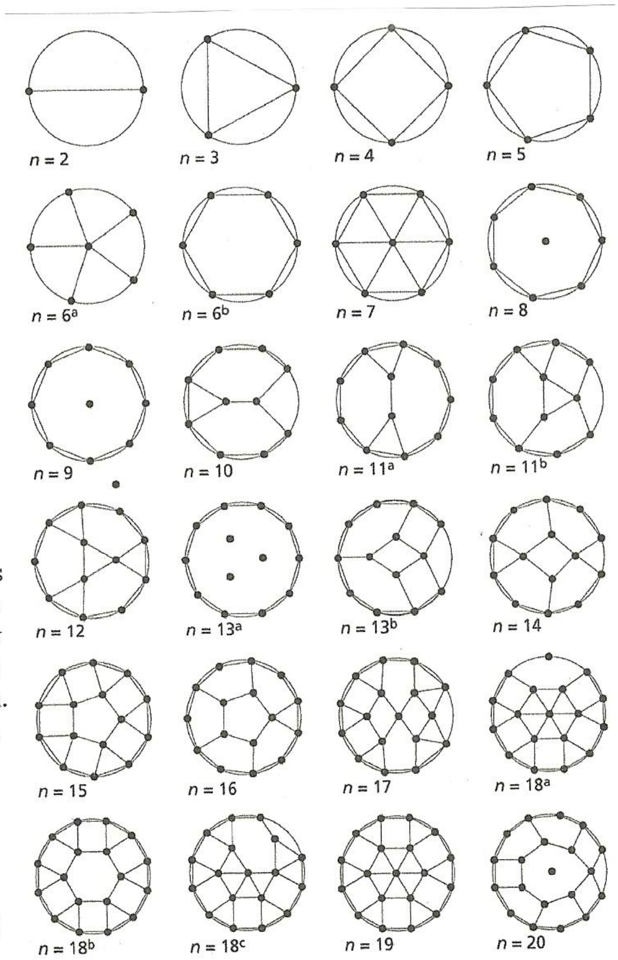
On the other hand, the "*qualitative*" issues of coping with complexity requires a discovery of "chunks of hidden knowledge". In the plots such chunks appear as subsets of points located on the circles versus subsets of points located inside the circles, where the points form amazing patterns which progress stunningly. *Amazing* is their visual quality of "*relativity*". *Stunning* is how the proportionality combined with symmetry creates beauty, and how paths with progressively interesting patterns unfold.

This authors preferred *pattern progression* in low Ns is N=4, N=9 & N=10. The preference dates back to Mensch, "A Progression-Graph Model for Packing Problems", Zeitschrift fur Betriebswirtschaft, 39 (1969), 39-48).

His preferred *pattern progression* in higher Ns is N=17, N=18a, 18b, 18c, and N=19, because it shows that a *break-up* of lower-N-symmetry is *path-breaking* to higher-N-symmetry. Since 500 B.C. such symmetry means beauty = truth. Inspect the range N<20. The prettiest is N=19.

Facit: *Breakthroughs* drive basic innovations, and basic innovations improve civilization.

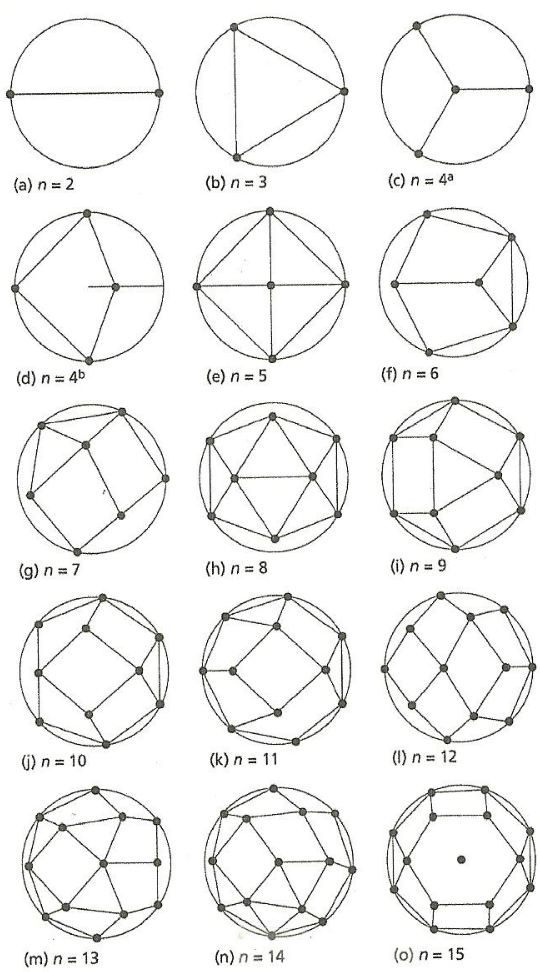
In practical work (Teaching, Team-advisory), this author employs his Convoy Models that shift focus from low N=4 to medium N=8 and higher N=15 for reasons given in Assembly 2.



Source of plots: Ian Stewart, "How to cut a cake – and other mathematical conundrums", Oxfort Univ. Press. For an application of the PPP to pattern projection on circular planes in physics start with K.J. Nurmela's work: "Minimum-energy point charge configurations on a circular disc", Journal of Physics A, Vol. 31 (1998), 1035-47.

Assembly 2: Projecting Complexity upon a Dome

Now, with the Assemply 2 of plots, we show how a more complicated projection method can assist us in *forward learning* and discovering additional possibilities in an augmented reality. With the Assembly 1 of plots we studied how a variation in N as a first proxi for complexity in opportunity landscapes provides us with some insights into a wealth of knowledge chunks. We saw how our brain can *project inside-out*, upon a piece of paper depicting circular units on a two-dimensional projection plane. Now we'll go 3D. Our brains are 3D, our head is round. Looked at from above, the head looks like a dome, like a hemispherical roof for *projecting outside-in.* We will plot such 3D-projections on plane 2D-paper. Do you follow? It's a double-down reduction of depicted complexity that suits our poor intuition when confronted with richly augmented realities.



The key point is that if you're projecting existing chunks of implicit knowledge, known from chaos and complexity theory to exist, and you're projectting the packages of points on hemispherical roofs, the patterns will be further distorted at the outer, steeper rim of the dome. That adds an additional perspective to the pattern proportions as N varys. It's the Principle of Perspectives in Proportions.

The Principle helps "forward learners" in fields such as "Educate to Innovate!", "Evolutionary Project Management" and "Innovation Rating". The plots show: In cases of major innovation, not just minor ones, the inventors/innovators are facing a complex co-evolution in both content and context (duality). Yet when undertaking an innovation process that is dually complicated, existing Perspectives in Proportions work like chunks of latent knowledge waiting to be found.

Source of Plots: Ian Stewart, op.cit.
The author's series of mathematical studies on perspectives in proportions started with the "Rank Restriction on the Quadratic Form in Indefinite Quadratic Programming", GSB Working Paper No. 3, Graduate School of Business, Tulane University, March 1970, published in Unternehmensforschung 1971. His journey of discovery culminated in "The Schumpeter Clock – A Dynamical Adaptive Expectations Model on Investment in Innovations". For this pioneering work G.O. Mensch received the Humboldt Price for Applied Mathematics and Informatics.

Annex II: Mathematical Basis of the Convoy Model for Tractor Projects

The Mathematical Basis of the “evolutionary” methodology used in the Convoy Model as applied to the Steering of Tractor Projects in case of major innovations is the Decomposition Principle of mathematical programming, especially Nonlinear Dynamical Programming with integrating Forward Learning on both the governance level (the Executive Team) and on the division of labor level (Innovation Teams).

This Management Science Basis is platform of the Strategy-Structure-Steering-Performance (SSSP)-Paradigm in Business Administration. In general terms, the SSSP-Paradigm had been conceived two generations ago as a norm for “The Function of the Executive”. This norm strongly emphasized corporate leadership (Strategy) and operative results (Performance). In later years, 1975 to 2000, the SSSP-Paradigm became more and more “evolutionary” as many product life cycles accelerated and got shorter, while successive waves of innovations made structural changes in industries and markets more radical (disruptive) than ever before. That put greater pressures on the Strategy-Structure (S-S) level of enterprise at the top and on the Steering-Performance (S-P) level of enterprise at the work-flow level of enterprise. And many formerly “mundane” projects turned into “tractor” projects with “evolutionary” requirements, with greater emphasis of shareholders on “outperformance” by managers and workers.

This is the state of affairs in 2011. There is a great need for improving the “Art of Innovating” in ways that are consistent with new economic Microfoundations and Management Science.

The Decomposition Principle composes three “chunks” of functions into an “evolutionary” framework: Nonlinear Dynamics of (A) the S-S-Functions of the executives, and of (B) the S-P-Functions of the workforce, and (C) the coordination function (SS-SP). The structuring framework for strategic decision making (A) and operative decision making (B) was sketched in section “Coping with Complexity…”. The key variable is N for x(i) = 0,1,2,…,N.

In evolutionary terms, the aspects of Steering, Timing of new product initiatives, and Starting such activities in synch with market timing and in anticipation of industrial changes is by far more complicated than coordinating traditional executive functions with stationary state vari- ables x(i,t) controlled by some mature business strategy S(x). In the Nonlinear Dynamic Pro- gramming framework these state variables are linked by connections x(ij) for i,j = 0,1,2…N.

Steering means activating (x(ij) =1) and deactivating (x(ij) =0) these connections in relativity to contents and contexts, and scheduling these activities towards attaining higher goals in the end than appeared feasible at the start, given the initial state of (lacking) knowledge. Tractor projects are scheduling such search and learning activities, aiming at a major innovation, by integrating and pulling along other (often minor) innovations. The attraction of the tractor is usually a headstart in the possession of some “chunk of knowledge”. The Evolutionary Dy- namical Programming method optimizes the strategic forward learning of the entire convoy.

It helps coordinating and steering the acquisition of new “chunks of knowledge”, implement- ting this knowledge into the scheduling of activities at times t such that the activated x(ij,t) form a cost-efficient and benefit-effective activity program: An evolutionary tractor project.