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The Cynefin Framework and Technical Competencies: a New Guideline to Act in the Complexity

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Abstract. The current socio-economical context is affected by extremely challenging factors such as the macro-economic crisis, the globalization of markets, the exponential growth in the complexity of systems, the continuous evolution of technologies and the criticality of requirements subject to rapid and sometimes uncontrollable evolution.

In such a competitive landscape the role of the future leaders gets essential. They shall be able, by means of a holistic, methodologically structured and flexible approach, to drive their programs through the implementation of the complex changes which are strategic to preserve the competitiveness. Such new leaders must be endowed with both strong technical skills, continuously trained in the key reference standards, and soft skills, useful for the strategic understanding of the evolutionary processes expressed by the markets and for the improvement of the complex relationships efficiency with the relevant stakeholders.

The development and implementation of optimized technical-managerial solutions is therefore essential, vital for the "feasibility" and competitiveness of front-running projects, and cannot succeed without a contextual analysis of the reference scenarios.

In this context the Cynefin Framework, an interpretative model of the different levels of the systems complexity, ranging from order to disorder, can provide a very effective support.

The goal of this paper is to develop a multi-faceted and comprehensive vision of the problems in the various domains of complexity, "contextualizing" the most effective management approaches and "soft and hard" skills of the leader.

The paper benefits of the input received during various sessions of the second Cohort of the INCOSE Technical Leadership Institute, where precious insight and feedback has been collected, especially from the TLI coaches, Patrick Godfrey, Michael Pennotti and Don Gelosh.

Systems Thinking

A significant number of modern enterprises qualify as complex. Their operational environment may change in short and irregular, unpredictable cycles, requiring the involved organizations to adapt internally in order to avoid degradation.

Systems science asserts that the optimal way to fully understand why a problem or element occurs and persists, is to understand its parts in relation to the whole. Systems thinking encourages understanding systems by examining the links and interactions among the elements that compose their entirety. The traditional, reductionist analytical approach to management is often counter-productive, since such analysis can only provide an understanding of the individual parts, while a holistic approach can be considerably more insightful for the understanding of the whole system. Systems thinking develops around a wide number of concepts which can provide the modern leader with the right tools for understanding complexity, among which some of the most relevant are:

- The analysis of behavioural patterns, which arise when the attention is placed on the way in which the parts work together, rather than on the parts themselves;
- The analysis of the purpose which the system is conceived to achieve, which is always a property of the whole and not found in any of the single parts;
- The analysis of emergent behaviour, which is exposed by the system when un-expected and un-experienced interactions occur among its parts, with typically negative consequences to be mitigated, but sometimes even positive consequences that can be exploited as opportunities for innovation;
- The analysis of the system context, which provides an understanding on the system scope and of its environment, which is the main concern of the present document.

The Cynefin Framework

A constructive help to better understand and manage the complexity of systems is provided by the Cynefin Framework, developed between 1999 and 2003 by Snowden and Kurtz on the basis of studies initiated by Boisot and Cilleris. The Cynefin Framework is an interpretative model of the different levels of complexity in which the systems can exist, ranging from order to disorder through five different contexts (or domains): simple, complicated, complex, chaotic and disordered. This framework helps leaders to identify the reference context in which their decisions have to take place, and suggests the proper courses of actions and operating logics to be applied. (Puliti, G.)

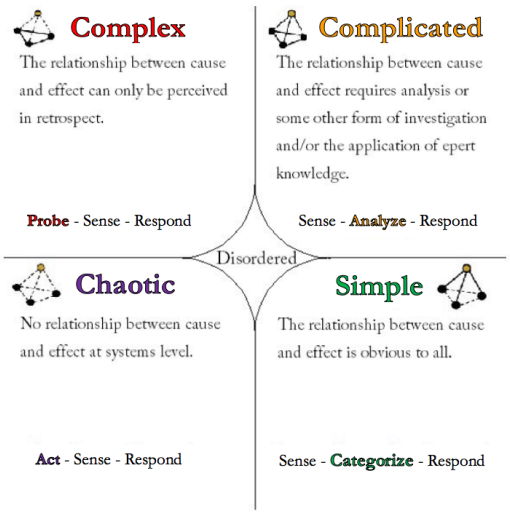

Figure 1: Cynefin Domains

Cynefin is not a categorization framework, (useful to classify data in a predefined taxonomic scheme), but it is a sense-making framework developed from already existing data (experience) trying to build a representative model of them. It is important to underline that no one domain is more desirable than any other. (Kurtz, C., F., 2003)

The Cynefin Framework is used primarily to understand the dynamics of situations, decisions, perspectives, conflicts, and changes in order to come to a consensus for decision-making. In fact, it is rare even for a leader to be able to know everything that should be known, but it is still necessary to make sufficient sense of what's going on around us, in order to act appropriately in response.

On the basis of what has been described above, a good leader should first identify the prevailing operating context, in order to make appropriate choices. Obviously, each domain requires a series of different actions and behaviors for the implementation of the most appropriate approach to solve the problem. For example, in the Cynefin Framework, simple and complicated contexts assume an ordered universe, where cause-and-effect relationships are perceivable, and right answers can be determined based on the facts, so this is the world of fact-based management. Complex and chaotic contexts instead are unordered, there is no immediately apparent relationship between cause and effect, and the way forward is determined on the basis of emerging patterns. This is a world represented by pattern-based management.

The Cynefin Framework therefore can help executives and leaders to better understand what kinds of tools, approaches, processes, or methods are more likely to be effective in any given situation. (Holt, S., 2011)

As well as from the complexity point of view, the Cynefin can also be seen from the uncertainty point of view, as Hugh Courtney explain in "Strategy Under Uncertainty", a framework for determining the level of uncertainty surrounding strategic decisions. He talks about a clear-enough future, alternate futures, a range of futures and true ambiguity. These levels of uncertainty can be associated with the Cynefin domains because increasing the complexity of the systems also increases uncertainty about the strategies to follow, as we will see in the next paragraphs.

Simple Context: The Domain of Best Practice

Simple problems often have a solution that appears to be immediate, to which we respond with actions or precise rules without even thinking about it too much. In this domain, we know exactly what is the question, and what is the optimal answer to solve a problem. This is due to stability and clear cause-and-effect relationships that are easily discernible by everyone, and which characterize the Simple Context. (Snowden, D., J., 2007)

Often, the right answer is self-evident and undisputed because in the Simple Context decisions are unquestioned and all parties share an understanding. This is referred to as the realm of the "**known knowns**", meaning that all relevant aspects necessary to solve a problem are well understood, and that we have full information available about each of them. The effort to be put in place can then be devoted to the identification of the optimal solution.

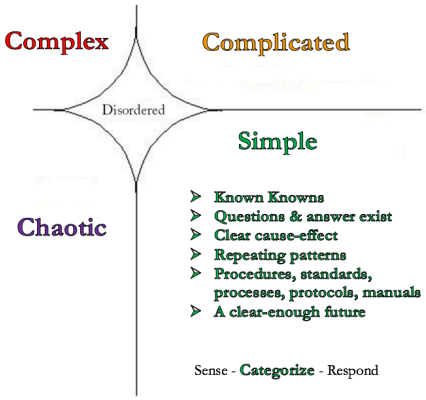

Figure 2. Simple Domain

In other words, the Simple Context can also be seen as the domain of the *ordered* and *obvious*. This is the domain of process engineering, in which knowledge is captured and embedded in structured processes to ensure consistency and optimize performance. As an example, areas that are subject to little change, or activities with orderly processing and fulfillment, usually belong here.

Dominant Managerial, Methodology and Leadership Style

As suggested by the name of the context is simple, for a leader, organize the management of information and procedures to apply to the entire system in three easy steps: **sense**, **categorize**, and **respond**.

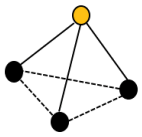

Figure 3. Simple Managerial Style

This is the domain of **best practice** so the focus is on efficiency. Simple contexts, properly assessed, require top-down management and monitoring, so we recognize a rigid and strict bureaucratic managerial style in which leaders and managers make use of prescriptive management techniques, relying on explicit knowledge which is captured and encoded in systems, processes, procedures as well as guidelines or manuals. (Puliti, G.) Figure 3 shows the leader's managerial style in the simple domain. The yellow vertex of the pyramid represents an element with strong authority who defines and imposes rules or actions. The summits at the pyramid's base represent different elements, stakeholders, experts or managers, who, through networking, are able to interact with each other. So the solid lines represent a strong link while dotted lines indicate a weak connection, less efficient than the previous one. Looking at Figure 3 we can see continuous lines connecting the top with the bottom of the pyramid to indicate a **command-and-control** style management**.** In the simple domain the hierarchy is decisive; in fact, having a single reference point, people are able to quickly implement defined line of actions.

The "obvious" approach is usually an operative process. Leaders and managers can develop a single forecast of the future that is precise enough for strategic development, as Courtney says. The residual uncertainty is irrelevant to making strategic decisions because the forecast, or answer, is sufficiently narrow to point to a single direction, like an arrow.

An example of situation relating to everyday life attributable to this domain are heavily process-oriented situations, such as administrations or production lines. (Dettmer, H., W., 2011)

The selection, implementation and use of a dedicated systems development life cycle model by an organization depends on several factors such as the nature and complexity of the system and the stability of system requirements. Therefore, the guidelines of the Cynefin theory could help the leader to apply the most effective and efficient methodology depending on the context in which the system is located in. For each context, we describe a methodology that best suits the domain in question by applying specific processes, methods and techniques. These are waterfall, incremental and evolutionary model.

In simple domains the most performing methodology is the waterfall model because it is a sequential design process that is most effective and efficient for engineering systems where the requirements are well known and stable or for updates to existing systems. It consists of performing the development process a single time. Simplistically: determine user needs, define requirements, design the system, implement the system, test, fix, and deliver. All system capabilities are delivered at the same time. Based on that, a leader operating in **simple contexts** can apply this approach successfully. The strengths of sequential methods are predictability, stability, repeatability, and high assurance. Process improvement focuses on increasing process capability through standardization, measurement, and control. These methods rely on the "master plans" to anchor their processes and provide project-wide communication. Specific attention is given to the completeness of documentation, traceability from requirements, and verification processes. It is very simple to understand and use. In a waterfall model, each phase must be completed fully before the next phase can begin. At the end of each phase, a review takes place to determine if the project is on the right path and whether or not to continue or discard the project. The major risks are related to the usually long implementation that could result in changing expectations/requirements and consequent technical obsolescence. (IEEE, Inc., 2011)

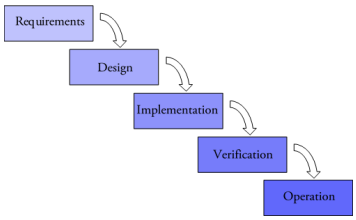

Figure 4. Sequential Approach

Risks

In each context examined in this discussion in addition to pragmatic view of issues and emerging guidelines, we will illustrate possible risks arising from poor management and leadership.

While typically quite effective, the hierarchical approach to obvious work is not entirely risk free. In fact, in this domain key risks are mis-categorization, resistance to change, entrenched thinking and complacency. (Snowden, D., J., 2007)

Mis–categorization involves performing the wrong procedure. Issues may be incorrectly classified within this domain because they have been oversimplified. Leaders who constantly ask for condensed information, regardless of the complexity of the situation, particularly run this risk.

Leaders are also susceptible to entrained thinking, a conditioned response that occurs when people are blinded to new ways of thinking by the perspectives they acquired through past experience, training, and success. It can be helpful for a leader to consider, in dynamics, the "entrainment breaking" movement in order to soft the entrenched thinking.

Third, when things appear to be going smoothly, leaders often become complacent. If the context changes at that point, a leader is likely to miss what is happening and react too late. In the Cynefin Framework, the simple domain lies adjacent to the chaotic for good reason. The most frequent

collapses into chaos occur because success has bred complacency. This shift can bring about catastrophic failure.

Johari window and ADKAR model, for example, suggest how leaders can mitigate or soft these risks.

Complicated Context: "Analyze" vs. "Categorize"

Complicated contexts, unlike simple ones, may contain several right answers, and though there is a clear relationship between cause and effect, not everyone can see it, so this is the ordered – not-obvious domain of experts. (Snowden, D., J., 2007)

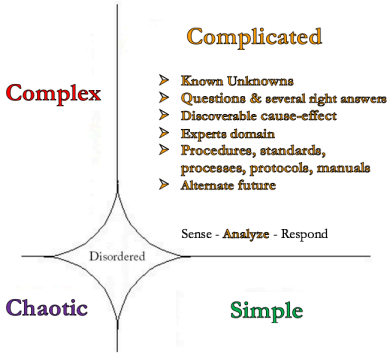

Figure 5. Complicated Domain

The **Methodology** is the base in this domain, which seeks to identify cause–effect relationships through the assessment of several solutions. This is referred to as the realm of the "**known unknowns**", meaning that all relevant aspects necessary to solve the problem are well understood, even though we don't have full information available about all of them. In this case the effort to be put in place is devoted to the analysis and tradeoff/optimization of different alternative solutions.

As in the simple context, any approach is governed by standard rules, procedures, protocols manuals etc. *Complicated* is the domain of **reductionism**. Is possible, in fact, to break a system down into constituent parts, because the solution of individual sub-systems leading to the entire solution. Work breakdown structures (WBS) are an example. An advantage is that lower entity issues are easier to handle, with a lesser degree of articulation. Individual sub-systems have a low interaction between them, although all works together within the same system, their functioning and behavior is quite independent so modifying one of them neighbors have low or limited repercussions. Moreover, the decomposition and recomposition process can not only solve full problem, but also optimize the system by adjusting the functioning of all its sub–systems. "The whole is the sum of the parts" is an assumed "obvious", but suitable for defining a complicated system. (Puliti, G.)

Dominant Managerial, Methodology and Leadership Style

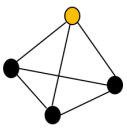

Figure 6. Complicated Managerial Style

In this domain, as shown in Figure 6, it is important both a command-and-control style, effective in simple domains, and the networking by which the leader can listen to the opinion of experts, both highlighted by solid lines. In Complicated Contexts leaders should be able to think analytically and methodically by making use of experiments, skills, surveys and planning scenarios. As we have seen, the reductionism helps experts, like systems engineers or project managers, to break a project down

into smaller packages, so different teams will take care of those lower complexity tasks in order to get them able to achieve their objectives more easily. Reductionism can be applied not only in project management (to derive the work breakdown structures, WBS), but also to steer a business analysis, where the market landscape is modeled into several interacting actors that play their role in the value chain as well as to fragment a complex architecture into subordinate components.

This is the domain of experts. While leaders in a simple context must sense, categorize, and respond, those in a complicated context must **sense**, **analyze**, and **respond** and often expert's opinion is required and, so, the networking gets strategically important. Deep knowledge and experience are beneficial as they improve the leader's analysis skills. Due to the complicated context calls for investigating several options, **good practice**, as opposed to best practice, is more appropriate. The future can be described as one of a few *discrete scenarios*. From the uncertainty point of view possible outcomes are discrete and clear.

Given the nature of complicated systems, the most performing methodology is the "incremental" strategy, much more flexible with respect to the sequential one. This approach determines user needs and defines the system requirements, then performs the rest of the development in a sequence of builds. The first build incorporates part of the planned capabilities; the next build adds more capabilities, and so on, until the system is complete. It generally applies to organizations that market new versions of a product at regular or preplanned intervals to remain competitive in the marketplace. Milestones are established at planned intervals to introduce a planned version of the system that can be released to the market. The system realized as a result of the concept stage can be a first version. Typically, the overall capabilities of the last version can be known at the start of system implementation. However, a limited set of capabilities is allocated to the first release. With each successive version, more capabilities are added until the last release fully incorporates the overall capabilities. (IEEE, Inc., 2011)

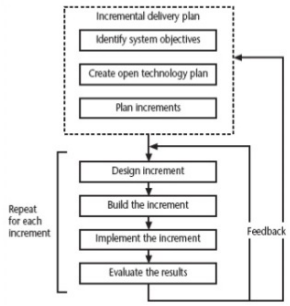

Figure 7. Incremental Approach

Risks

Key risks here are *over-thinking*, *over-analysis* and once again *entrenched thinking*. Over–analysis is the result of a desire to make the "right" choice among a few viable options. Taken to an extreme, over-analysis leads to "analysis paralysis", where a group of experts hits a stalemate, unable to agree on any answers because of each individual's entrained thinking, or ego. Entrained thinking is a danger in complicated contexts, but it is the experts (rather than the leaders) who are prone to it, and they tend to dominate the domain. When this problem occurs, innovative suggestions by nonexperts may be overlooked or dismissed, resulting in lost opportunities. To get around this issue, a leader must listen to the experts while simultaneously welcoming novel thoughts and solutions from others. (Snowden, D., J., 2007)

Like simple context, Johari window and ADKAR model can be helpful to mitigate or soft these risks.

Complex Context: The Domain of Emergence

Unfortunately, most of human activities are not amenable to a "just" complicated model that is made up of individual sub–systems together. Unlike complicated contexts where is possible to know at least one right answer, in a complex context right answers can't be easily ferreted out.

Complex Context is the realm of the "**unknown knowns**", (Sivertsen, M., 2011) meaning that we are aware that there are relevant aspects related to the problem which are not well understood, and little information is available about the problem itself. The effort to be put in place is then devoted to try to understand the right questions, even if often the answers are only available in hindsight.

So, another way to call this domain is: *unordered–obvious in hindsight*; it's only after the fact that we can understand why things happen. Once that happened, the event is rationalized in retrospect. As further reading the "*black swan"* theory is suggested.

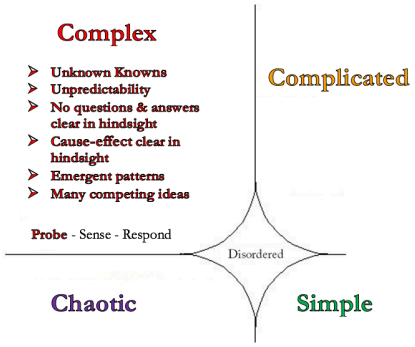

Figure 8. Complex Domain

Structurally, a complex system is composed of highly interconnected sub–systems between them: a single one is closely linked to neighboring, and depends on the interaction that is established between them. Therefore, it is difficult, if not impossible, apply the concept of reductionism because subsystems may not work, or work in a completely different way when it is separated from the whole system. As a consequence leaders who try to impose order in a complex context will fail.

Dominant Managerial, Methodology and Leadership Style

This is the domain of complexity, which studies how patterns emerge through the interaction of many sub–systems. Emergent patterns can be perceived but not predicted, understanding why things happen only in retrospect. Leaders are in front of a *range of potential futures*. That range is defined by a limited number of key variables, but the actual outcome may lie anywhere. There are no natural discrete scenarios under uncertainty point of view, like complicated contexts. As explained in the previous domain, solid lines represent a strong link between elements, while dotted lines express weak connection instead. In this domain, it is very important to allow the growth of the players **networking** as displayed in the following organization structure (Figure 9).

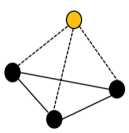

Figure 9. Complex Managerial Style

A leader should patiently allow the path forward to reveal itself instead of attempting to impose a course of action, to create **probes** to make the patterns or potential patterns more visible before taking any action. After that he should respond by stabilizing desired patterns and destabilizing those he does not want. So, the best leader approach is **probe**, **sense** and then **respond**. Leaders allow patterns

to emerge, and determine which ones are desirable will succeed. In this way, they will discern many opportunities for creativity, new business models and innovation. **Fail fast**, **learn fast and safe fail** is the right way to do innovation.

In this domain is impossible to do detailed planning because it would only be a waste of time. Managers and leaders should be able to manage and lead in a strategic environment which is emergent and uncertain and therefore need the ability to envision their system in a "larger" one within which it exists at a given time. It is essential to have an iterative, incremental development with holistic and synthesis skills. Open discussions, where people generate innovative ideas to help leaders in decisions and strategies are welcome. Dissent and diversity are encouraged to push the emergence of well-forged patterns and ideas. Leaders shall manage starting conditions and monitor for emergence because outcomes are unpredictable in a complex context. In short leaders could follow guidelines close to the systems engineering methodology called evolutionary. The "evolutionary" strategy develops a system in builds but differs from the incremental strategy, previously described, in acknowledging that the user need is not fully understood and not all requirements can be defined up front. In this strategy, user needs and system requirements are partially defined up front, and then are refined in each succeeding build.

The evolutionary approach generally applies to organizations that market new versions of a product at regular or preplanned intervals. Initially the requirements for the system are partially defined and then refined with each successive version of the system as lessons learned from the use of an early version are translated into new desired capabilities. In this case, implementation of new versions could be done serially or in parallel with partial overlapping. As with versions developed using the incremental approach, different versions can be operated and supported in parallel. Particular care should be taken, however, to maintain configuration control of each version so that operation, training and support procedures are appropriate to the version being used. Often, a new version with enhanced capabilities could replace an earlier version, or a block modification can be made to the earlier version to incorporate the new capabilities of a later version.

As told before this approach applies mainly to **complex systems** for which, obviously, requirements are not well understood even though the need for the system is understood and approved. Customer feedback could be used to enhance the capabilities of a future version of the system and it allows to take advantage of emerging technologies. (IEEE, Inc., 2011)

An example of evolutionary approach is the Incremental Commitment Spiral Model (ICSM), shown below. (Wiley, J. (ed.), 2015)

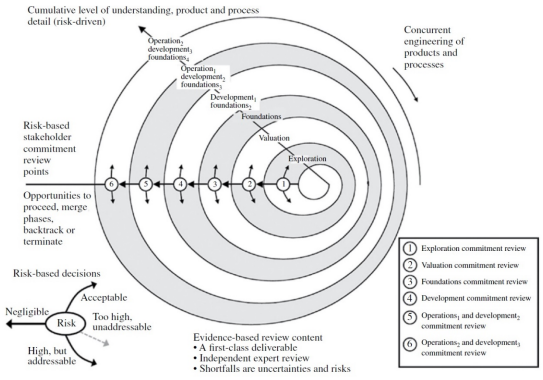

Figure 10. Spiral Model

The main characteristics of the three engineering life cycle models previously described are synthesized in the figure below (Boehm, B., 2014):

Development strategy	Define all requirements first?	Multiple development cycles?	Provide interim function?
Once-through (Waterfall)	Yes	No	No
Incremental (Preplanned Product Improvement)	Yes	Yes	Maybe
Evolutionary	No	Yes	Yes

Figure 11. Summary of Strategy Characteristics

Adaptive Leadership. The unpredictability and the complexity previously analyzed call for a new type of leadership. Organizations are capable of intelligent, purposeful collective action, actions taken to influence their environments in desired directions. Like all living organisms, organizations can learn, adapt and grow. They too have life cycles of birth, growth, maturity and eventual decline. Organizations are living systems, being composed not just of capital goods and technology, but of people.

Adaptive leadership impacts the environment. It addresses a very active form of leadership, not a passive effort taken merely to adjust to circumstances as found. It is a new approach far from the traditional and ancient way to lead organizations as machines, assuming people as parts of machines-mindless extensions of impersonal processes.

Adaptive leadership provides practical steps to maximize the chances of success. A way is not treating a new adaptive challenge in complex domains as a "complicated" technical problem. In the latter attention is mainly focused on activities, job descriptions are detailed and constraining, roles are rigid, policies are mostly oriented toward control what people can't do. In adaptive challenges, instead, attention is focused on value-added outcomes, job descriptions are intentionally broad to allow flexibility, roles are fluid and policies encourage people to take a "can do" mindset to find solutions. (Heifetz, R., 2009)

Complicated matters, as technical problems, have solutions in the current know-how through the organization's current structures, procedures, and ways of doing things. Differently adaptive challenges can only be addressed through changes in people's priorities, beliefs, habits and loyalties. Making progress requires going beyond an authoritative expertise to mobilize discovery, shedding certain entrenched ways, tolerating losses, and generating the new capacity to thrive anew even if this inevitably causes resistance to change.

As representative model of adaptive leadership methodology we can consider the OODA loop. John R. Boyd, a military strategist and United States Air Force Colonel, conceived the OODA loop that is a structured pattern of observation, orientation, decision, and action. In the first step leaders collect data by means of the senses; then make an analysis and synthesis of data to form one's current mental perspective; determine a course of action based on one's current mental perspective and finally they act with the physical playing-out of decisions.

This is a loop because, of course, while this is taking place, the situation may be changing. Sometimes it is necessary to cancel a planned action in order to meet the changes by adopting an **adaptive** mindset. (Horney, N., 2011)

Figure 12. OODA Loop

Another model, quite similar to the OODA loop previously analyzed, consists of three elements: observing events and patterns, interpreting what we are observing and intervening to address the adaptive change.

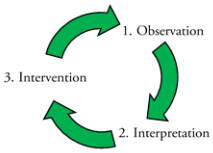

Figure 13. Adaptive Leadership Model

In exercising adaptive leadership, the goal is to make observing as objective as possible. Getting off the dance floor and onto the balcony is a powerful way to do this. It enables leaders to gain some distance and see patterns in what is happening that are hard to observe if they are stuck at the ground-floor level. Once observed a leader must holds more than one interpretation having the ability to view the same set of data from several different perspectives. The final step, intervention, should reflect leaders' hypothesis about the problem.

This continually self-refining iterative process is designed to cycle through the three stages in a particular order as the stages build on one another. The practice of reflection (Observe and Interpret stages) is integral to learning and leading adaptively. Reflection is an important process by which knowledge is developed from experience. When reflecting, a leader considers an experience that has happened and try to understand or explain it, which often lead to insight and deep learning, or ideas to test on new experiences.

Adaptive leadership reflects the actions of leaders who are proactive, foresee opportunities and put the resources in place to go after them. They are astute students of their environments generating creative options for action, strive to improve their personal openness to new ideas and stay abreast by being lifelong learners. In this way, a leader can maximize the chances of success by minimizing failures.

Overall adaptive leadership offers an opportunity to improve individual performance by offering the sensation of being responsible and active player of the organization. This has significant influence on the motivation and commitment which the individual has for his work and for the organization as a whole, and is a trigger for peak performance.

Risks

Although with the adaptive leadership model for a leader it is possible to improve the guidelines for action in complex contexts, this not excludes risks inherent in this domain. Some of these are *desire for determinism*, *failure to learn, revert to simple strategies, impatience* and *over-control*.

Of primary concern is the temptation to fall back into traditional command-and-control management styles, to demand safe fail business plans with defined outcomes. Leaders who don't recognize that a complex domain requires a more experimental mode of management may become impatient when they don't seem to be achieving the results they were aiming for. They may also be scarcely able to tolerate failure, which is an essential aspect of experimental understanding. If they try to over control the organization, they will preempt the opportunity for informative patterns to emerge. Leaders who try to impose order in a complex context will fail, but those who set the stage, step back a bit, allow patterns to emerge, and determine which ones are desirable will succeed. They will discern many opportunities for innovation, creativity, and new business models.

Chaotic Context: The Domain of Rapid Response

In the Chaotic Context, the relationships between cause and effect are impossible to determine because they shift constantly and no manageable patterns exist, only turbulence, so the search for the right answers would be pointless. (Snowden, D., J., 2007) There are not any connection or connectivity. We are in the state of not knowing what type of causality exists. This is an *unordered* domain, the realm of **unknowables**.

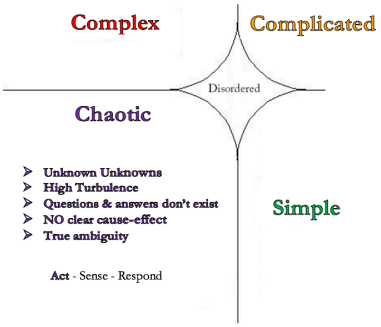

Figure 14. Chaotic Domain

This is referred to as the realm of the "**unknown unknowns**", meaning that we don't even know which are the relevant aspects related to the problem, and no information is available even to be able to define the problem. The effort to be put in place in this case can only be devoted to take immediate action, and then to try to make sense of what happened, trying to reduce chaos.

Dominant managerial, methodology and leadership style

In a chaotic context, multiple dimensions of uncertainty interact to create an environment that is virtually impossible to predict (*true ambiguity* in Courtney's framework). It might not even be possible to identify, much less predict, all the relevant variables that will define the future. So, this domain requires immediate action by leaders and managers in order to make sense of factors in the external and internal environment of the company. Figure 15 shows an organization structure composed of only dotted lines, so, it is not important authority, bureaucratic managerial style or experts networking, it is important to act as quick as possible.

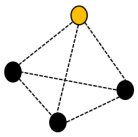

Figure 15. Chaotic Managerial Style

Often this domain is called the "Super Hero Domain": only a superhero can, maybe, fix the problem, enter in the burning building and save everyone. If the super hero is not available, so the best advice that can be given in these cases is *run away*: in other words, if you understand that the project is migrating in the fourth quadrant, the chaos, the best thing to do, both from an economic point of view that corporate convenience is abort the project. If this is not possible, a leader can only expect a high probability of failure. (Puliti, G.)

This is the domain of **novel practice**. Here a leader must **act**, quickly and decisively to reduce the turbulence, **sense** where stability is present and from where it is absent and **respond** by working to transform the situation from chaos to complexity, where the identification of emerging patterns can both help prevent future crises that discern new opportunities.

The chaotic domain is nearly always the best place for leaders to impel innovation. People are more open to novelty and directive leadership in these situations than they would be in other contexts. One excellent technique is to manage chaos and innovation in parallel: as soon as you encounter a crisis, appoint a reliable manager or crisis management team to resolve the issue. At the same time, pick out a separate team and focus its members on the opportunities for doing things differently. If you wait until the crisis is over, the chance will be gone.

The Domain of Disorder

The last domain is the central, the disorder, in which leaders try to interpret the same situation with different points of view.

Often in a group using the Cynefin framework, leaders agree on what the extremes of the four domains mean in the context they are considering, but disagree on more subtle differences near the center of the space. As a result, individuals try to interpret the central space on the basis of their preference for action. Those most comfortable with stable order seek to create or enforce rules; experts seek to conduct additional research and accumulate new data; politicians seek to increase the effectiveness of the network; and finally, the dictators, eager to take advantage of a chaotic situation, seek absolute control. In this domain people seem to pull issues towards the context where they feel most empowered by their individual capabilities and perspectives.

Decision in Multiple Contexts: A Leader's Guide

After a general description of five contexts of Cynefin framework, it is clear that a leader to be effective must be able to shift his decision–making styles to match changing business environments, adapting his managerial response depending on the context. By correctly identifying the governing context, staying aware of danger signals, and avoiding inappropriate reactions, leaders can manage effectively in a variety of situations. Good leadership requires openness to change on an individual level. Truly adept leaders will know not only how to identify the context they are working in at any given time but also how to change their behavior and their decisions to match that context. They also prepare their organization to understand the different contexts and the conditions for transition between them. A deep understanding of context, the ability to embrace complexity and paradox, and a willingness to flexibly change leadership style will be required for leaders who want to make things happen in a time of increasing uncertainty. Emotional intelligence enables technical leader to negotiate effectively towards win-win situations. (Godfrey, P., 2016) It is now clear that special skills are required to manage systems in any context, and these are analyzed in next paragraph.

Leader's Skills and Competencies

As we seen, in each scenario leader should have certain skill and competencies to ensure a winning leadership. In this section, we will analyze some aspects related to the leader's approaches in a specific domain.

Simple. In this domain leaders can answer exactly to **five Ws** (What?, Who?, When?, Where? and Why?) because they have nearly all the knowledge they need to make decisions that produce highly predictable outcomes. They can observe what's going on, sort it into the appropriate pigeonhole and respond with tried and true procedures. With strong authorship managers delegate and gives instruction to their collaborators, communicating clearly so that everyone knows what to do and do it in the best way. Good communication practices and correct use of technical vocabulary need particular care because this may reduce technical ambiguity but, on the other side, could create barriers for an audience unfamiliar with the technology. Different cultures/languages often use different words or phraseology to convey a similar meaning. Therefore, paradoxically, a leader has to be adaptable to understanding the communications from a diversity of technical disciplines.

Complicated. Leaders operating in the complicated domain know some of what they need to know to make informed, effective decisions. They also know the questions they don't have the answers to, and they have a reasonably good idea of how to find those answers. They can't proceed on the basis of existing knowledge, so they must sense and analyze, which may point them in the direction of searching out the information they need but don't have. Is necessary collaboration with other experts to analyze the problem, doing brainstorming (it allows to express ideas and comments), and give a solution. The winning leader has a flexible mindset, perhaps doing research on the state of the art of

technology and most advanced methodologies, being open to criticism and a polyhedral view of the problem, not to conflict with other experts. Once he founds the solution, he proceeds by implementing appropriate principles and processes. Therefore, he should encourage contributions from various stakeholders, maintains a favorable environment that stimulates people to provide varied contributions but keep the actors focused on a common vision, harnessing their fruitful contributions. Without this, collaboration is impossible and the resulting relationships are merely transactional. To summarize, a good leader, acting in complicated domains, has an altruistic, assertive and **analytical mindset**.

Complex. In this context, the best strategy is not to consult experts. It is wise to investigate before taking action, collecting coherent theories and ideas about what to do, and seeing the effect of a particular choice by using an agile approach, identifying, understanding and mitigating risks. In complex or innovative projects, the recognition of the emergence of unintended outcomes ("emergent properties") are particularly important. Given the rapidity of emerging pattern changes, a good leader should be the main team player, a catalyst for cooperation, in order to be focused and meticulous while acting in complex systems. For this reason, it is not enough to have an analytical mindset, as complicated contexts, but a leader should think ahead of current task, being visionary, pioneer, having a good visualization of situation. He views a problem in a **holistic and systemic** manner, thereby enabling better understanding, better decision making and a better solution. He should translate complexity into clear operational directions. He shapes and communicates vision and strategy simply in order to reduce system complexity.

Chaotic. A leader must become a "super hero" with courage and an exceptional character. To entice the crowd to follow him, he must be determined to act decisively and quickly as possible to avoid the "collapse" and try to move the system to simple or complex domain. These attributes are the ones that help progress the system/organization forward on a consistent and sustainable basis. All this leads to the emergence of mutual trust between the leader and the team. Mutual trust is at the center of all attributes linking them together and guide the leadership model.

Cynefin Dynamics

From the leader perspective, the moving paths between Cynefin domains are as important as the domain characteristics themselves; moving across boundaries requires a shift to a different model of understanding and interpretation as well as a different leadership style. A deep knowledge of the functional characteristics of the different movements in the framework increases the leader effectiveness of the decision-making response to rapid change.

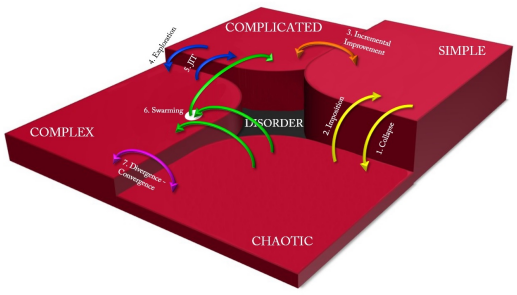

Figure 16. Cynefin Dynamics

Movement at the known-chaos boundary

This boundary is the strongest of the four, in which a perfect boat sails very close to a devastating storm. For this reason, this boundary is the most dangerous and, at the same time, the most powerful if treated with respect.

The devastating movement from simple to chaotic domain is called *Asymmetric collapse* (Item 1). Generally, enterprises settle into stable symmetric relationships in known space and fail to recognize that the dynamics of the environment have changed until it is too late. The longer the period of stability and the more stable the system, the more likely it is for unexpected threats to provoke a movement into chaos. The leader does not see things that fall outside the area of his expectation, because he is shortsighted and his models are outdated, bringing the system to break and to fall in chaos. Chaos is not always harmful; it is also a space where leaders can enter into intentionally to open up new opportunities and to create the conditions for innovation.

Imposition (Item 2) is the forceful movement from chaotic to simple domain. The consequence of asymmetric collapse is chaos, and the consequence of chaos is frequently imposition of order. In catastrophic situations, as the price of order, are usually tolerated conditions that would has previously been unacceptable. The problem with this dynamic is that it introduces a new rigid stability that often breaks in its turn.

Movement at the known-knowable boundary

This is the permeable boundary where the scientific method operates; some movements to un-ordered domains are often involved in most scientific works (hunches, networks, shared beliefs…).

Incremental improvement (Item 3) is movement from complicated to simple domain and back, repeatedly. This is the engine of technological growth but it can become pathological if the cyclic movements become a means to try to indefinitely perfect a theory.

Movement at the knowable-complex boundary

The boundary between complicated and complex domain complements the simple-complicated border as an engine of new ideas and front running science. It is not as permeable as the simple-complicated boundary because transitions must translate between order-unorder and from one set of rules to another.

Exploration (Item 4) is movement from complicated to complex domain very useful to the growing of new ideas and opportunities by reducing or removing central control without a total disruption of connections. An enterprise could, for example, allow network communication to identify new possibilities of improvement in the organizational field. This action obviously reduces the hierarchical control and, so requires not only good planning and awareness of the "shadow" side of the organization, but also careful (but unobtrusive) monitoring of the situation.

Just-in-time (JIT) *transfer*, *exploitation* (Item 5) is movement from complex to complicated domain that involves the selective choice of useful stable patterns in complex space. The selected patterns and related knowledge are stabilized into the ordered space when it is needed (just-in-time).

Movement at the complex-chaotic boundary

This boundary, like the simple-complicated one, is fluid and difficult to delineate. In nature, systems move back and forth across this boundary often to achieve their own organic order.

Swarming (Item 6) is movement from chaotic to complicated throughout the complex domain. Imposition of order is most appropriate in symmetric conditions, but under asymmetric conditions, or when whole-system interventions are required, a leader needs to move from chaos to complex domain. The transition from chaotic to complex is carried out by creating multiple attractors, or swarming points, as seeds of future patterns, whereas a transition from chaotic to simple domain requires a single strong attractor. In the complex domain leader has the possibilities to see the growing of such patterns forming around the attractors; those he finds desirable he stabilizes in the complicated domain; the undesirable ones are destroyed.

Divergence-convergence (Item 7) is the cyclic movement from complex to chaotic. This allow the generation of a rich variety of patterns to facilitate sense-making.

Movement through chaos

This movement is usually applied when it is necessary to break rigid structures to make transitions much more manageable and when a strong disruption is the only way to break up a strong but unhealthy stability. Sometimes the chaotic space is also a means for a temporary disruption of all connections (possibly within a restricted context) to stimulate new growth.

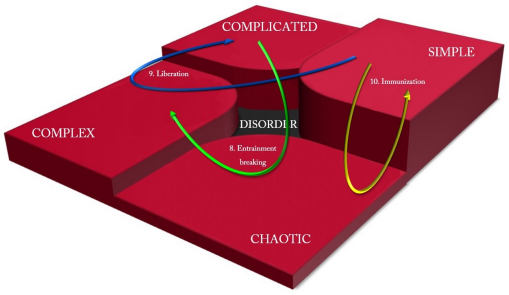

Figure 17. Cynefin Dynamics Through Chaos

Entrainment breaking (Item 8) is the periodic movement from complicated to chaotic to complex domain. This is sometimes referred to as "creating a burning platform". This is a common approach to disrupt the entrained thinking of experts by creating a more fertile space of interactions from which leaders can select stabilization points for the movement to the complicated domain. This method is used to create and validate new sources and structures for decision-making.

Liberation (Item 9) is the periodic movement from simple to complex to complicated domain. Enterprises operating in simple domain often need to change the status quo in order to facilitate the creation of new emerging ideas and opportunities. They, so, have to move in the complex domain by, for example, recruiting external specialist staff or redistributing new responsibilities in the organization. Then, analytically and methodically, leaders can choose the most viable ones moving toward complicated domain.

Immunization (Item 10) is the temporary movement from simple to chaotic domain not enough to destabilize the whole system. It serves mainly two purposes. First, it shows the devastating force of chaos preparing leaders to face those forces. Second, immunization brings new perspectives, which cause radical disruptions in stable patterns of thought and lead to changes and new complex patterns. This movement enable lateral thinking, prevent entrainment of attitudes destroying the glue of stagnant views. (Kurtz, C., F., 2003)

Case Study: SRT

The Sardinia Radio Telescope (SRT) is an INAF's (National Institute for Astrophysics) 64 m diameter radio-telescope, located near Cagliari, Sardinia, Italy.

The parabola's active surface (SSA) consists of 1008 aluminium panels driven by 1116 electro-actuators; such complex system is required to compensate for thermal/gravitational structure deformations and to guarantee high accuracy of the parabola geometry (Figure 18).

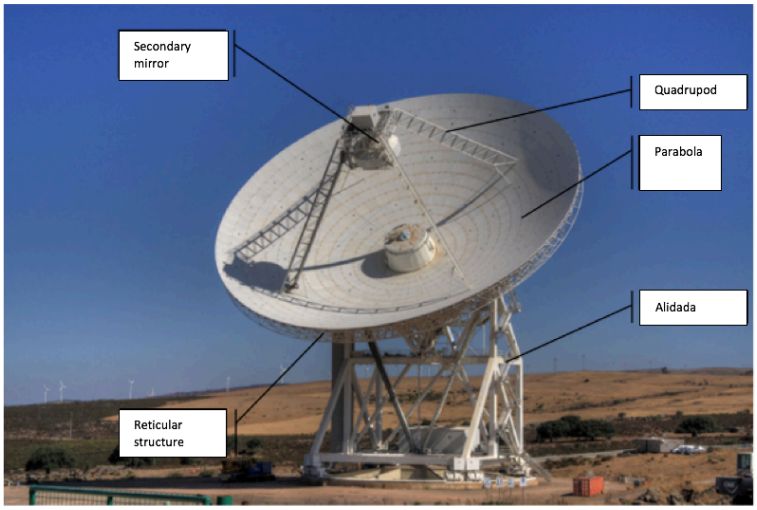

Figure 18: The Sardinia Radio Telescope (SRT)

Unfortunately, after some years of operations, an evident oxidation phenomenon in the active surface system (SSA) has compromised both the functionality and the mechanical characteristics.

This event generated different thought currents, each of them suggesting a different approach. The scientific community proposed to complete the observation run in progress; the administration focused on problems related to the funds availability necessary for maintenance activities; the operational team proposed solutions to guarantee compliance with all safety regulations; the President team assessed the impact in terms of costs, time and image of any work; the technical offices were interested in the identification of damage causes and the development of effective refurbishment solutions.

Therefore, lacking a strong attractor element to impose a single decision line, the whole system has been in an unordered situation where it was difficult to define the most appropriate action strategy. This context is represented by the non-ordered domain in the Cynefin framework.

Everything changed when a big opportunity came: on 15 September 2017, the Cassini probe, after having made its last passages between the Saturn rings, would have disintegrated into the planet's atmosphere. NASA (National Aeronautics and Space Administration) together with the JPL (Jet Propulsion Laboratory) identified in SRT a possible instrument for latest data acquisition from the probe, opportunity that INAF decided to take without hesitation. The refurbishment activities had to be closed within 30 August 2017.

The consolidation point, represented by INAF's President decision, enabled the system transition from non-ordered domain to an ordered one, described by Cynefin as Simple (movement 1 in Figure 19). In this phase all the bureaucratic and administrative procedures were implemented to start the refurbishment program.

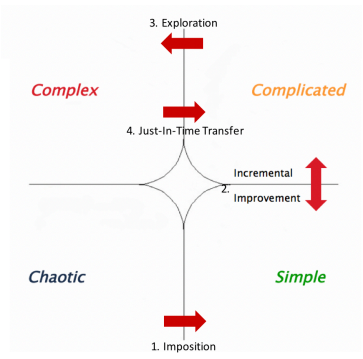

Figure 19: SRT Dynamics

The support of an experts-team got necessary at once. So, a working group was created, made up of scientist, engineers and researchers, to analyse the problem' roots (FEA, FEM, metallurgical analysis, microphotographs, crystallographic analysis…etc.) and to develop concepts of possible solutions.

This was the transition to the Complicated domain of Cynefin, called also the domain of experts (movement 2 in Figure 19).

The non-exhaustive outcomes of the experts-team determined the need of a broader spectrum of solutions, searchable in the know-how of external entities such as new research institutions, universities, academies or industries (preliminary market consultations). It opened up new thought streams and innovative ideas were developed by the community at large, so the system moved in an unordered domain, the Complex one of the Cynefin framework (movement 3 in Figure 19).

During this phase, whole days were dedicated to brainstorming where anyone proposed their own ideas and solutions, filtered by constraints such as time, costs, risks. In this way different "emerging patterns" were revealed, among which the viable ones were stabilized and those deemed unacceptable were discarded.

The experts working group analysed and formalized the accepted viable solutions (here we are again in the Complicated domain, movement 4 in Figure 19) in the technical specifications of the call for tender, won by a Group of Economic Operators GEO.

The works execution, regulated by the contract, fell within the Simple domain of the Cynefin.

Obviously, during the refurbishment activities, various unforeseen problems emerged requiring the experts working group intervention to support the GEO. The system so periodically moved from the Simple domain to the Complicated one, and vice versa. In fact, the solutions first analysed and then agreed in the experts' domain were then implemented according to what was established by the procurement code, leading the system back into the Simple domain of the Cynefin framework (movement 2 in Figure 19).

At the end, the SRT Radio Telescope was delivered ten days in advance with respect to the scheduled time.

In conclusion we can say that the detailed knowledge of all methodologies, processes and dynamics present in the Cynefin framework has significantly contributed to the job success, which made the radio telescope suitable to receive the latest data from the Cassini probe before her "dive" in Saturn.

Conclusion

In the complex environment of the current business world, leaders often will be called upon to act against their instincts. They will need to know when to share power and when to wield it alone, when to look to the wisdom of the group and when to take their own counsel. A deep understanding of context, the ability to embrace complexity and paradox, and a willingness to flexibly change leadership style will be required for leaders who want to make things happen in a time of increasing uncertainty. Taking as inspiration the table contained in document "A Leader's Framework for Decision Making - David J. Snowden", this paper presents a summary of all the contexts analyzed in this discussion and their associated features, risks and possible responses to those risks. We have considered the dynamics of each domain of the Cynefin framework, analyzing how a good leader can best manage every domain, trying, if possible, to simplify complexity and understand the differences between different movements to increase the effectiveness and efficiency of his response to various contexts.

	Contest's characteristics	Leader's job	Danger signals	Response to danger signals
Simple	Repeating patterns and consistent events Clear cause-and-effect relationships evident to everyone; right answer exists Known knowns Fact-based management Standard rules procedures, protocols or manuals	Sense, categorize, respond Ensure that proper processes are in place Delegate Best practices Communicate in clear, direct ways Understand that extensive interactive communication may not be necessary Clear line of authority No ambiguity Command – Control style Waterfall approach	Complacency and comfort Desire to make complex problems simple Entrained thinking No challenge of received wisdom Overreliance on best practice if context shifts Wrong categorization	Create communication channels to challenge orthodoxy Stay connected without micromanaging Don't assume things are simple Recognize both the value and the limitations of best practice Johari window ADKAR model
Complicated	Expert diagnosis required Cause-and-effect relationships discoverable but not immediately apparent to everyone; more than one right answer possible Known unknowns Fact-based management Standard rules procedures, protocols or manuals Methodology Reductionism	Oligarchic style Sense, analyze, respond Create panels of experts Listen to conflicting advice Good practice Iterative approach	Experts overconfident in their own solutions or in the efficacy of past solutions Over - analysis Expert panels Viewpoints of nonexperts excluded	Encourage external and internal stakeholders to challenge expert opinions to combat entrained thinking Use experiments and games to force people to think outside the familiar Johari window ADKAR model
Complex	Flux and unpredictability No right answers; emergent instructive patterns Unknown unknowns Many competing ideas A need for creative and innovative approaches Pattern-based leadership Know in hindsight Black swan theory Research	Probe, sense, respond Create environments and experiments that allow patterns to emerge Increase levels of interaction and communication Use methods that can help generate ideas: Open up discussion (as through large group methods); set barriers; stimulate attractors; encourage dissent and diversity; and manage starting conditions and monitor for emergence Emergent practice Fail fast, learn fast, fail safe Holistic and synthesis skills Agile, Evolutionary approach OODA loop	Temptation to fall back into habitual, command-and-control mode Temptation to look for facts rather than allowing patterns to emerge Desire for accelerated resolution of problems or exploitation of opportunities Failure to learn Impatience Over control	Be patient and allow time for reflection Use approaches that encourage interaction so patterns can emerge
Chaotic	High turbulence No clear cause-and-effect relationships, so no point in looking for right answers Unknowables Many decisions to make and no time to think High tension Pattern-based leadership	Act, sense, respond Look for what works instead of seeking right answers Take immediate action to reestablish order (command and control) Provide clear, direct Communication Super hero Draconian order imposition Dictatorial and charismatic Novel practice	Applying a command-and-control approach longer than needed "Cult of the leader" Missed opportunity for innovation Chaos unabated	Set up mechanisms (such as parallel teams) to take advantage of opportunities afforded by a chaotic environment Encourage advisers to challenge your point of view once the crisis has abated Work to shift the context from chaotic to complex

Figure 18. Contexts Summary

The more systems are small and simple, the more useful and effective is a waterfall approach. As the size or complexity increases, incremental or evolutionary approaches become more effective.

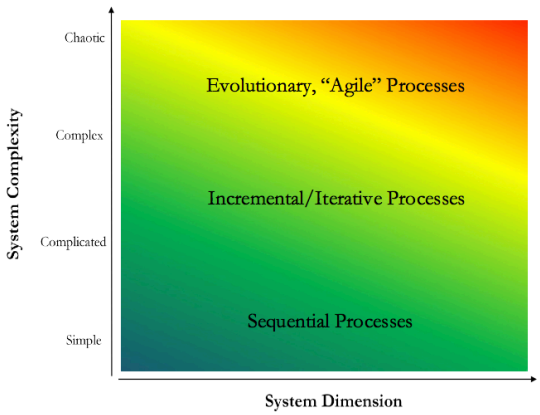

Figure 19. Approaches vs System Dimension and Complexity

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Biography

Davide FIERRO graduated in Mechanical Engineering at the University Federico II of Naples where he got also the PhD in Industrial/Management Engineering. Then he completed his SE-PM education at Luiss Business School and Bocconi School of Management. He has about 20 years' experience in PM and SE disciplines with his first role in 1997 as VST Telescope Deputy Project Manager. He spent about two years @ ESO Observatory Center in the Atacama Desert, Chile, where he was also responsible for the integrating and testing activities of the VST Telescope. Now, as head of INAF's Engineering Office, Fierro has chief technical/managerial responsibilities in several international projects as SKA, Square Kilometer Array, of which he is the Program Manager of the whole Italian Technical participation. He coordinates the INAF's involvement in the European SST (space surveillance and tracking) program in close synergy with the Italian Space Agency and the Italian Ministry of Defense. He collaborates with various Universities in disseminating Systems Engineering discipline. As coordinator of the Italian Incose SE-PM Working Group he collaborates with the PMI in order to improve the synergy between SE and PM methodologies. Fierro is member of the Defense, Security and Space Committee of the PMI, of the TLI Technical Leadership Institute of INCOSE and of Boards of several International Projects, as SKA-LFAA. Fierro is INCOSE CSEP "Certified Systems Engineering Professional" and ISIPM, "Italian Institute of Project Management" certified.

Stefano PUTINO graduated in Electronics Engineering at the University of Rome Tor Vergata (2015) and he specialized in Space and Security domain. He collaborated with Leonardo S.p.A. in designing microwaves filters and high frequency amplifiers for the Italian Navy Systems.

In 2016 he won a fellowship at INAF, "National Institute for Astrophysics", and is now involved, as Engineer, in some Astrophysics projects. Since January 2017 he is INCOSE member.

Lucio TIRONE is co-founder and Technical Director of Aster SpA, and President of the Italian Association of Systems Engineering (AISE) - INCOSE Chapter Italia. After graduating in Electronics Engineering in 1997, he specialized in the design of Microwave devices and antennas, and in the development of Object-Oriented software for the analysis of Electro-Magnetic propagation in urban and suburban environments.

He then developed a wide multidisciplinary experience in the Conception, Design, Development and Testing of complex Systems in several technological domains, including Defence, Maritime, Aerospace, Transportation and Security. In 2012, first in Italy, he acquired the INCOSE CSEP certification, and is also a certified IBM Rational Systems and Software Engineering Sales Professional, and OMG-Certified Systems Modeling Professional. He is teacher of Systems Architecture / Design courses within several Master's Degrees in Systems Engineering, and is a member of the INCOSE Technical Leadership Institute.