Long term effects of systems engineering practices disregard in Spain within a European centered aerospace market

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***Abstract*—**Project management involves customer needs, resources cost and completion time. Systems engineering takes care of customer needs. But it is also a means to ensure that milestones along the duration of a project are well respected. This would ensure a sufficient amount of time for testing in factory before the different subsystems under test are finally taken on site for assembly. The consequences of not respecting this time are analyzed in the form of a system dynamics diagram. The unavailability of systems engineering training courses is considered here as one of the reasons why the national aerospace industry lacks productivity. This mismatch between Industry and Academia can then be addressed by systems engineering education.

***Keywords*—**Systems engineering, project management, requirements engineering, economic growth, industrial development, and aerospace industry.

I. Introduction

CURRENT situation in Spain in comparison to the rest of Europe is not helping young researchers and scientists to make the most out of their university education. It is not clear that Industry currently absorbs the best of the talents produced. It is not clear neither that Spanish industry manages to acquire the best of the talents from outside.

Here, some reforms are discussed that should lead Spain towards the path of growth. These reforms are both educational and entrepreneurial, and should foster Industry-Academia interaction. Industry-Academia interaction has been promoted by the Research Directorate-General (European Commission) as a valid mechanism in order to foster the generation of research results [1]. This is necessary to generate a market able to make the most out of both worlds. The public administration is left out of this interaction although it usually constitutes an important partner of industrial activity.

The impression of the author of this article is that formalization of activity decreases from Administration to Academia. Here, Industry constitutes an intermediate stage within the Administration-Academia continuum. This means that activities seem to be better formalized in Administration, then Industry, and finally Academia. It has also been observed that people working in administration tend to appreciate formalization schemes to a highest degree. Industry support for these is negligent sometimes, maybe driven by lack of sight with regards to how a good integration should be. Respect for the general framework proposed by the Spanish Systems Engineering Association would serve as a good indicator of this appreciation.

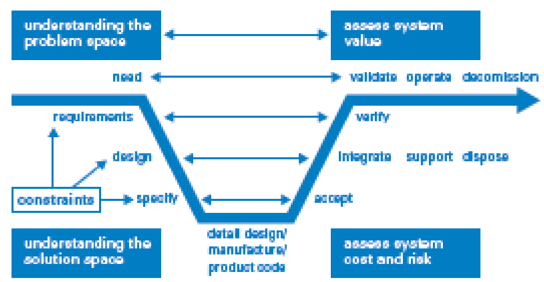

Fig. 1: Basic simulation of a model of system (http://www.onlineincose.org.uk)

The structure of the Spanish industry does not grant respect for these integration schemes, for industrial development seems to be obstructed by the interest of the shareholders. This means that relationships among industrial players are corrupted. Corruption of relationships can also be observed in the French and Portuguese industries to a certain extent. It also involves relationships between the markets and ESA, or even internally within a given organization.

Also within the kind of activities that should support respect for these integration schemes is the value of simulation and model-based systems engineering [2]. If simulations were used to a greater extent and validation of design was made on paper, less effort would get expended when manufacturing takes place. Also, not so many errors would be committed then.

Design validation could also be made by using information and communication technologies. The use of information and communication technologies for other purposes like on-line learning has also been researched by the author of this article [3]. The author has also been involved in studies concerning knowledge management [4] and the learning organization [5]. Finally, the role of information systems in these domains has been analyzed [6]. These could also be used for other objectives like system behavior simulation, which should be

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useful to check that different parts within a given system can be well integrated before the actual manufacturing process takes place.

II. Problem Formulation

The current situation in Spain has made many young very well trained people get away to the rest of Europe and the United States of America. One of the fundamental reasons why this is occurring is the lack of opportunities offered by the internal market. It is discussible whether entrepreneurial spirit could partially compensate deficiencies in the assignment of labor, but it is clear that it is difficult without a certain amount of capital.

The contents of the current section establish a potential set of reasons why the internal market in Spain suffers an adaptation mismatch with regards to the rest of Europe. This problem, general within the Spanish economic structure, is also tangible in the aerospace market [7]. Among the different subsections analyzed, most of them have to do with the lack of recognition of the systems engineer figure within the organizational culture. There is also a small mention to the lack of social recognition existing for development activities in general.

The added value of systems engineering within this framework is easily explainable from the following: knowledge production is maybe the kind of work where still there is more path to walk. In particular, the new engineering systems perspectives based on models involve a greater use of simulation software tools [8]. This is to verify and validate the designed product in the course of execution of a project before going ahead to the manufacturing process. The corresponding concept is depicted in Fig. 2.

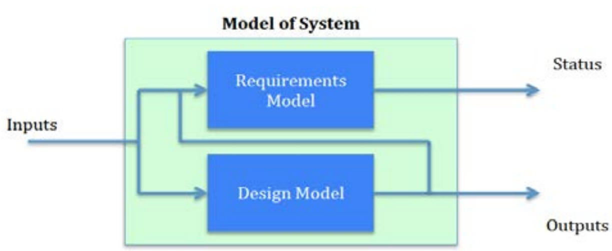

Fig. 2: Basic simulation of a model of system [9]

The problem with it is the time needed for completion of the overall process when additional time is requested for validating the system before implementing it physically. However, it saves a lot of money, as far as it is not necessary to experiment with real pieces of material [10]. If the pieces are put altogether before manufacturing takes place, it is possible to make sure that measurements are correct, and integration is not going to give problems.

However, dealing with impatience of line managers is often very complex. Quick decisions are usually taken that jeopardize the project in the long run. For example, if a system is not correctly tested in factory, then testing it on site can be counterproductive at least for two reasons:

1. The image given to the customer is not very good. It denotes lack of seriousness on the side of the company that is performing the integration activities.
2. The role of the systems engineer is not facilitated. He has to be more devoted to discovering where the failure comes from when integration takes place instead of analyzing new emergent behaviors.

A. *Research Initiatives*

European Commission’s Charter and Code seem to be a reasonable proposal to raise the social welfare of researchers within the Union [11]. Money does not usually constitute the main reason for embarking in a research career, but it is also true that earning a living is difficult without a minimum amount.

The degree of implementation of the initiative is unclear in Spain. Since it was first introduced in 2005, it is not clear that it has gained further advancement in the Spanish parliament. This can imply considerable differences with regards to the rest of Europe.

The Charter and the Code suggest measures as basic as coverage for social insurance [12]. Pension can probably wait, but it is clearly a big disincentive to investigate without having health sufficiently covered at least.

It is clearly an issue that no action is taken to make the implementation of the Charter and the Code advance in Spain. However, thinking that an improvement of the situation will take place in Spain without it is clearly neglecting something important. Good researchers will fly away looking for a place where at least food is available in their dishes when the day ends [13].

So an action is required from the side of the government in order to make sure that human capital drain stops happening in Spain. The proposal of the author is that implementation of the change be made structural [14]. Then it would not depend on what is the color of the political party governing the nation at each moment of time.

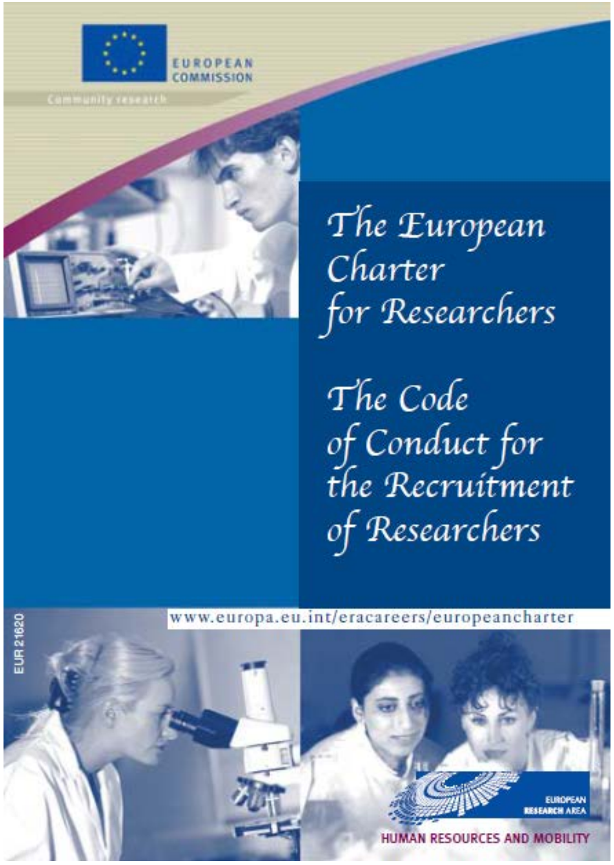

Fig. 3: European Charter and Code (http://ec.europa.eu)

B. Career Paths

A simple research in http://www.spaceareers.com shows that salaries for the same activities in Spain or Italy compared to Northern Europe differ at least in a two factor. This basically means that an engineer working in Germany or the United Kingdom easily earns double of what he can earn in Italy or Spain.

The situation for an engineer is better, however, than for a researcher. At least, he has both health coverage and pension scheme; financial security seems to be better ensured [15]. This is clearly a distinction. But internal market changes can somehow get established so that regulations are introduced and therefore health and pension rights be granted to researchers.

How is an engineer willing to develop a career going to work in Italy or Spain – where he can hardly live from his work – if he can earn a decent living in Germany or the United Kingdom? Conversations of the author with researchers have shown that also career paths offer a reasonable perspective of development. This leads to a reasonable progression compared to what could be expected in Spain.

Fig. 4: Northern Europe salaries (http://www.spacecareers.com)

Fig. 5: Southern Europe salaries (http://www.spacecareers.com)

The situation is not only applicable in engineering, but also in biology, for example. Recent conversations in EUMETSAT with a Spanish research scientist coming from the United Kingdom show that career as is planned there is unthinkable in the Kingdom of Spain. The same researcher in Spain would have been exposed to years of carrying out lower level tasks and bearing negligence with regards to his or her proven merits.

The lack of recognition in Spain is also something that can be observed in the systems engineering domain. Some leading organizations like INDRA feel proud of carrying out systems engineering works. However, it is not clear that basic integration policies are at all respected. It is not about what is done, but how. Experience of the author is also that opinions of systems engineers are not usually respected by line managers as much as those of product developers.

C. Market Structure

Economic behavior in Spain is clearly dominated by a little number of players. The Spanish aerospace industry comprises actors like INDRA, INSA or CASA. The problem with the current structure of the internal market in Spain is that neither INDRA nor INSA show respect for basic systems engineering procedures or practices. The issue is not only addressable to the Spanish market, but also to France and Portugal.

How is an engineer willing to develop a career going to work in Italy or Spain – where he can hardly live from his work – if he can earn a decent living in Germany or the United Kingdom? The issue under analysis is related somehow to respect for development cycles and milestones along the project duration [16].

An ideal situation should show respect for tests in factory. However, the behavior of the industry sometimes tends to bypass the corresponding step and try to make those tests directly on site. This is counterproductive at least for two reasons:

1. The image of the company selling the system is not well preserved in front of its final customer.
2. The overall effect of this policy within a project is that it makes the role of the systems engineer tedious.

The situation is even more desperate when colleagues and subcontractors tend to behave in a similar way. Many times, and in Spain especially, the systems engineer is expected to behave as a subject who is intended to validate himself the subsystems that compose the overall system. Therefore, his or her efforts are doubled. On the one hand, he or she has to validate the subsystems composing the overall system. On the other hand, he or she has to validate the overall system composed of lower level subparts. The attitude of line managers does not support neither the accomplishment of integrations in due time. A good start should be able to recognize the due length of a real project.

There is an extended idea of trying to sell a subsystem to the customer as quickly as possible in order to get paid neglecting that on site acceptance tests may become unbearable if this is the case. Under this assumption probably lies the idea that integration is an easy step where things will go right as far as the individual subsystems are working. Problems arising from the interaction among the individual parts are generally neglected [17].

Unexpected behaviors come from the overall interaction among different subsystems [18]. It is not an easy task to show line managers the need to be respectful with results in factory acceptance tests when there is quick money behind. Experience shows that it may be more appropriate to wait and announce the delay to the customer instead of trying to implement something that does not work. Moreover, it adds credibility to the team carrying out integration activities.

It is very frustrating for the systems engineer to verify that project managers usually neglect systems engineering contributions to the accomplishment of a project. In fact, it is not understandable how this can happen, for systems engineering constitutes one of the cornerstones of project management, along with time and cost, as depicted in Fig. 6.

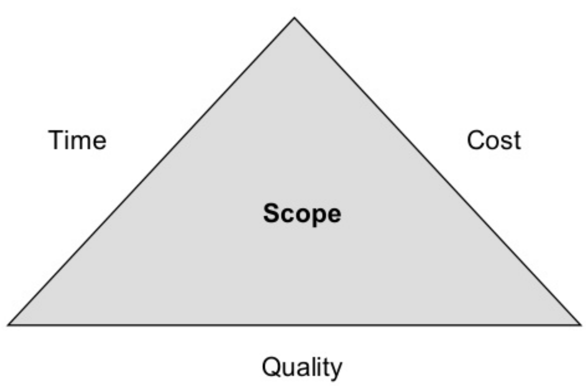

Fig. 6: Triangle for project management [19]

III. Problem Solution

The solution to the problem above should be based on a greater societal respect for systems engineering practices in general. This would need to start in Academia, then be preserved in Industry and be requested by the Administration.

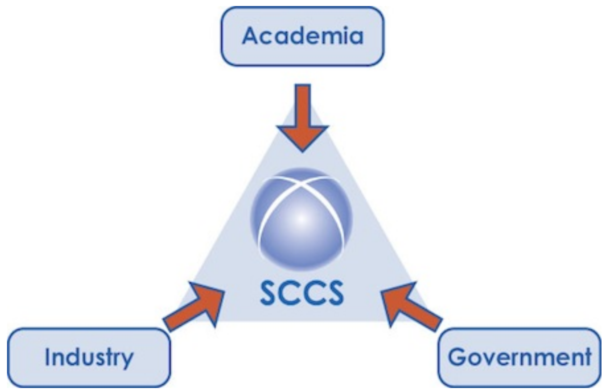

Fig. 7: Industry-Academia-Government partnership (http://www.sccs.org.uk)

Industry-Academia partnership has been fostered by European Commission's Research Directorate-General as a successful means of promoting interaction between both worlds. Support for the role of the government within this interaction is not clear from the funding schemes promoted by the Research Directorate-General.

However, the role of Administration as a driving force for the development of the market cannot be discussed. It is clear that it sets the rules for many of the industrial development activities within a country or union [20]. In the case of Spain, it can be the Ministry of Defense. European Space Agency would be a good equivalent at a European level.

A. Academia

Spain is the only country within Western Europe along with Ireland showing no involvement at all with offering of systems engineering courses at university. This is problematic because without a valid methodology the successful completion of complex engineering projects is uncertain. Cost overruns and time delays are more likely when the systems engineering component of project management is neglected.

Therefore, a gradual involvement with university regarding these practices is proposed here. It could start with basic systems engineering courses at degree level, just like the ones offered for project management [21]. In fact, understanding project management is difficult without respect for customer needs. Hence, to a certain extent, systems engineering is a necessary step towards project management.

Systems engineering education should continue at PhD level, but it is difficult to ask for it when it is neglected in the most basic levels. However, comparison with surrounding countries also shows mismatch with regards to this.

Fig. 8 shows an example of what is being discussed here.

Europe

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Ph.D. in Industrial Engineering (Czech and English)

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Fig. 8: Systems Engineering Academic Programs [22]

Other conclusions that can be taken from the report relate to the number of universities which are showing respect for the discipline along different continents. Table 1 contains a summary of them.

Continent	Universities
Africa	5
Asia	26
Australia	2
Europe	32
North America	130
South America	11

Table 1: Systems Engineering and Industrial Engineering Academic Programs [22]

This is also represented in Fig. 9 for clarity. It can clearly be seen that differences between Europe and North America demand some political action in Europe with regards to educational planning. It is reasonable to think, however, that more ways exist, apart from university planning, in order to reach the goal of having a workforce receptive to systems engineering methodologies.

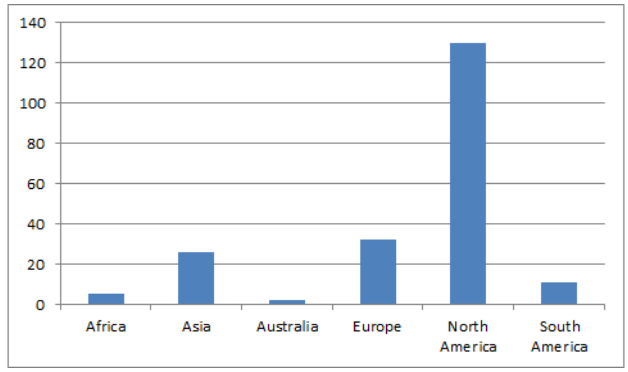


Figure 1: Systems Engineering and Industrial Engineering Academic Programs [22]

B. Industry

One of this ways is industrial actors having training courses available on the matter. Training for project management is extended to a higher degree. To a certain extent, most organizations understand that project management is certainly a must for the successful completion of their development projects.

However, the situation is not equal with systems engineering. It is true that EADS and therefore CASA constituted a good example of respect for systems engineering procedures [23]. Therefore, training courses are offered within EADS in order to foster this management paradigm. However, the situation is not equal with INDRA.

One of the reasons why the author of this article thinks that EADS and CASA constituted a good example of respect for systems engineering is the availability of INCOSE training courses. It is true that many people may observe the introduction of courses from foreign countries as insulting their idiosyncrasy. However, also it has to be noted that it is the paradigm with regards to which most of the civilized countries around the world have reached an explicit agreement, structured most visibly as groups of people trying to work towards a common objective [24].

Should the tendency towards not accepting this fact become pronounced, then a lack of adjustment between Spain and the rest of Europe will occur. This will make difficult for the Spanish market follow the rest of Europe. The author of this article is also worried about how policies respectful with systems engineering are perceived sometimes internally. They are indeed contemplated as counterproductive with regards to the internal culture of the organization to which they have been imposed [25].

It should be somehow emphasized that in fact it is necessary for organizations to internalize these policies if they are willing to continue being competitive in Europe. Otherwise, they will be perceived as corrupt or unaware of the complexities related to the completion of European projects.

C. Government

Government is the part of the Industry-Academia-

Government continuum where these practices are better accepted. It is not clear that full implementation of them has been reached in the Ministry of Defense, for instance, but interest has been openly manifested on their side.

The author is not aware of answers from the rest of the ministries. However, it cannot be discussed the driving force of the Ministry of Defense as a funding source for engineering projects within the Spanish industry [26].

It is funny however that only the ministries are showing some respect for these methodologies, as far as the author of this article is concerned. It is clearly a disadvantage that cannot be neglected. The problem with having an industry not contemplating the schemes promoted by the Systems Engineering Spanish Association as a need is:

1. Line managers do not probably have the necessary sensibility to see that a lack of respect for this approach will unavoidably lead the industry to a collapse.
2. Line managers are more worried about making money and sustaining their current position rather than discovering and promoting new talents.

To a certain extent, it is the same kind of problem that can be observed in any democracy. People in power for only a few years try to secure their position first, and then the one of the others. The problem with this approach is that securing one's position is usually at expense of taking from others what cannot be obtained from oneself.

That is the reason why democracy without a mediating role like the one of a monarchy cannot really be productive in the long term. A royal figure is usually necessary for the people to make sure that a dialogue is established. This allows them to have someone who has to respond to the judgement of his or her public image in the long term.

IV. Model Simulation

A. Figures and Tables

A reasonable description of the long term effects of systems engineering practices disregard is depicted in Fig. 10. These long term effects are indeed explainable by what J. Forrester calls counterintuitive behaviors of social systems [27]. This means that some of the political decisions that are taken at a given moment in time to solve a given situation can lead to counterproductive behaviors in the long term.

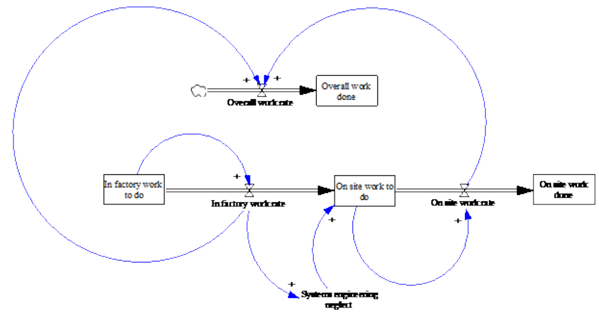


Fig. 10: System dynamics diagram with systems engineering disregard nonlinear effects

A parameterization of the model is contained below. Initial work to do in factory has been fixed to 10 tasks. It is carried out at a certain work rate, which should cease when the stock of work is finished, leading to the following expression:

$$In\ factory\ work\ rate = \frac{In\ factory\ work\ to\ do}{k_1}$$

The constant k_1 represents the speed at which the in-factory work is carried out. A higher constant means the work is carried out slower than when a lower constant is used. It will initially be supposed that work is carried out quickly:

$$k_1 = 10$$

The quicker the in-factory work is performed, the greater the systems engineering practices neglect [28]. This is explained by letting equipment get out from the premises without a sufficiently high level of testing, leading to further need for testing on site. The results of the testing on-site can then lead to the discovery of additional errors that may need to be corrected, probably having to take equipment again to factory.

It has been decided to represent effects of this disregard as a constant affecting the on-site work to do as follows:

$$On\ site\ work\ to\ do = \int In\ factory\ work\ rate \times Systems\ engineering\ neglect - On\ site\ work\ rate$$

This disregard is maybe neglecting something relevant from systems engineering theory, which is to acknowledge that systems integration almost always, if not always, generates unexpected behaviors. These behaviors are part of what Crawley et al. (2004) call emergent behavior [18].

On the other hand, on site tasks are also carried out at a certain work rate, also to cease once the work stock finishes:

$$On\ site\ work\ rate = \frac{On\ site\ work\ to\ do}{k_2}$$

In principle, the constant k_2 represents how quickly the on-site work becomes completed. It will be fixed, because it is not purposive of this work to analyze more than the systems engineering practices neglect effect:

$$k_2 = 10$$

From here, the on-site work done is then built as indicated below:

$$On\ site\ work\ done = \int On\ site\ work\ rate$$

The overall work rate is an addition of the in-factory work rate and the on-site work rate:

$$Overall\ work\ rate = In\ factory\ work\ rate + On\ site\ work\ rate$$

Finally, the overall work done can be composed as follows:

$$Overall\ work\ done = \int Overall\ work\ rate$$

Once the initial work rate of 10 is tested, it will be analyzed what happens if it is increased. It will be then be set at 20. This leads to the following:

$$k_1 = 20$$

This will generate an additional set of results that will need to be compared with the original ones, probably showing that an increase of the in factory work rate leads to an increase of the overall work done. This is coherent with the idea that less work in factory should lead to a multiplicative factor within the on-site work to do.

V. Results Validation

An execution of the model depicted in Fig. 10 with a value of $k_1 = 10$ leads to the following set of results:

$$In\ factory\ work\ to\ do = 10$$

$$On\ site\ work\ to\ do = 3$$

$$On\ site\ work\ done = 5$$

$$Overall\ work\ done = 15$$

Results are depicted below in Fig. 11, Fig. 12, Fig. 13, and Fig. 14 for $k_1 = 20$.

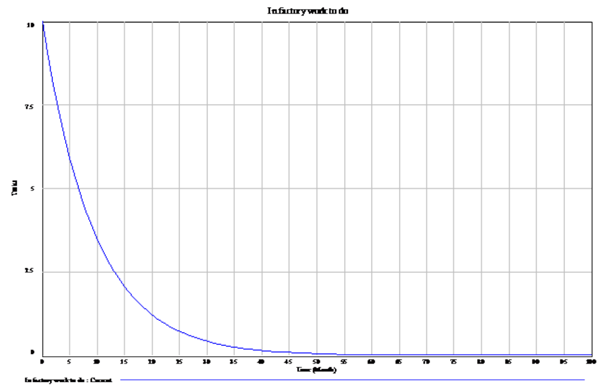


Fig. 11: In factory work to do with $k_1 = 10$

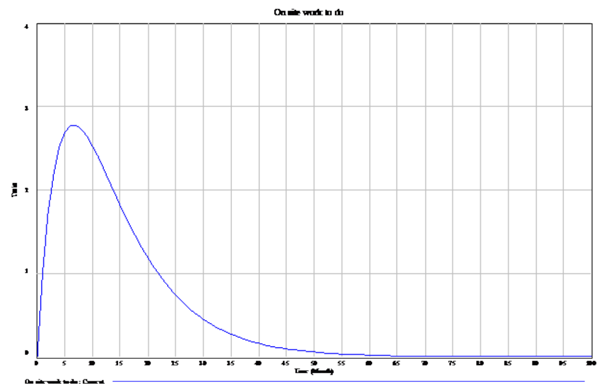


Fig. 12: On site work to do with $k_1 = 10$

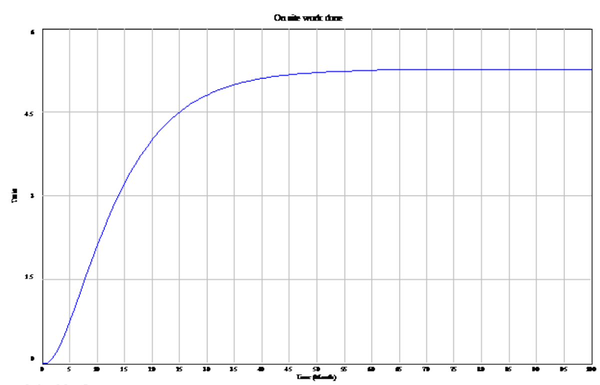


Fig. 13: On site work done with $k_1 = 10$

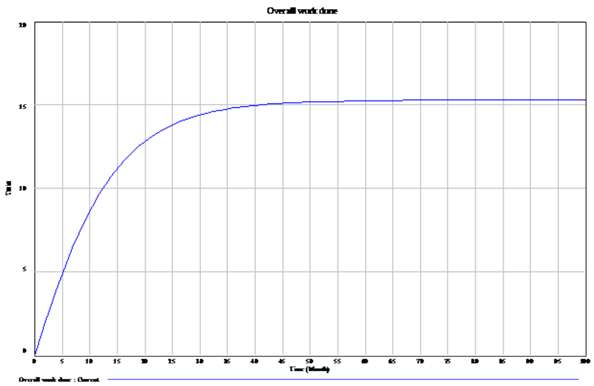


Fig. 14: Overall work done with $k_1 = 10$

An execution of the model depicted in Fig. 10 with $k_1 = 20$ leads to the following set of results:

$$In\ factory\ work\ to\ do = 10$$

$$On\ site\ work\ to\ do = 1$$

$$On\ site\ work\ done = 3$$

$$Overall\ work\ done = 10$$

Results are also depicted below in Fig. 15, Fig. 16, Fig. 17, and Fig. 18 for $k_1 = 20$.

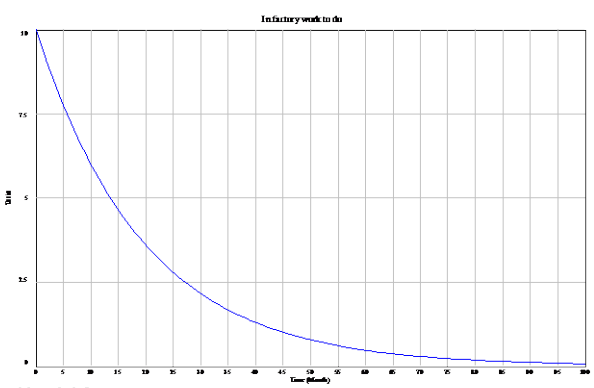


Fig. 15: In factory work to do with $k_1 = 20$

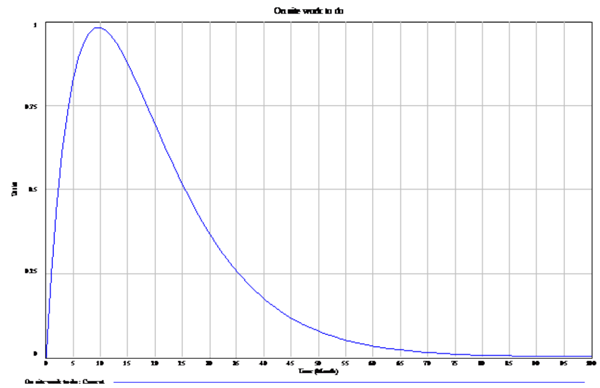


Fig. 16: On site work to do with $k_1 = 20$

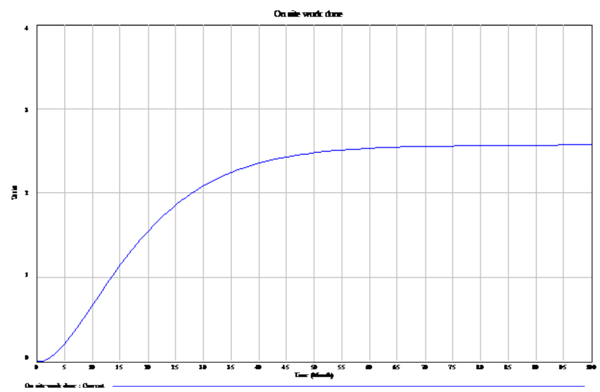


Fig. 17: On site work done with $k_1 = 20$

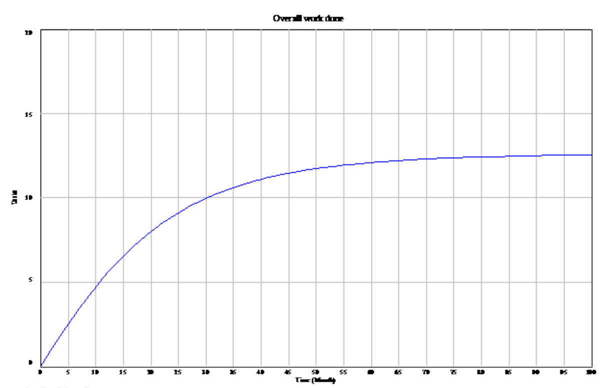


Fig. 18: Overall work done with $k_1 = 20$

The quicker the in-factory work is performed, the greater the systems engineering practices neglect. This is explained e.g. by letting equipment get out from the premises without a sufficiently high level of testing, leading to further need for testing on site. The results of the testing on-site can then lead to the discovery of additional errors that may need to be corrected, probably having to take equipment again to factory.

The result of this higher in-factory work rate is clearly an increase of the in-factory work to do, the on-site work to do, the on-site work done, and the overall work done. Definitely, this is in accordance to the original idea that a lower time to perform work in-factory should lead to a comparably very much greater amount of work on-site.

VI. Conclusion

While it is clear that many organizations in Spain presumable carry out systems engineering tasks, it is not so clear that procedures used to reach the desired result are actually optimal. This means that engineering projects usually produce valid systems, but not in the most efficient way necessarily.

Fig. 19 shows how systems engineering effort can effectively reduce the time and cost needed for finalizing a project. The greater the systems engineering effort, the lower the cost and schedule overruns will be.

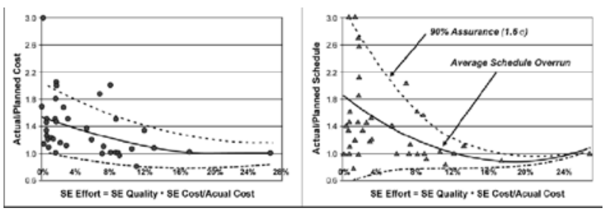


Fig. 19: Cost and Schedule Overruns correlation with Systems Engineering Effort [16]

While it is clear that systems engineering is not a unique contribution to project management, it is also self-evident it can greatly compensate cost and time. To a certain extent, it can be seen as if a greater effort on that could compensate cost and time efforts within the triangle for project management depicted in Fig. 6.

It is not clear, however, that systems engineering decisions are taken into account respectfully by line managers. To a certain extent, it is the impression of the author of this article that line managers are more worried with product development instead of with system replicability [29].

This is particularly true in the Spanish industry, where the internal market does not offer the conditions necessary for the respect of the profession [30]. The idea of just building a prototype and testing it almost directly on site without an intensive factory test is a not very constructive situation that has been experienced during integration by the author of this article.

It also seems there is a greater interest in the Northern countries for approaches that foster the development of generic systems that can be customized to particular projects. This involves the fact of paying attention to documentation with the purpose of replicability [31].

It is also unclear that best of talents can be preserved internally when a European and worldwide market exists which seems to be far more respectful with a systems engineering career than the Spanish internal market [32]. This somehow starts with salary levels, but can also be translated to the time devoted to the development of the projects.

Organizational culture is not supportive with these approaches, and tends to foster the generation of isolated products, taking for granted that systems engineering is more in charge of showing what subsystem within the overall integrated system is guilty for an unexpected erroneous behavior instead of having to be convinced of the suitability of each of the subsystems prior to integration. This approach is indeed a defensive routine that hampers honorable development schemes [33].

It is also against a healthy policy of knowledge generation, which should be stored in an organizational repository [34]. If knowledge is indeed in the heads of its generators rather than on paper, the risk exists than when those people are leaving the organization, their associated knowledge leaves away with them.

But it is also the opinion of the author of this article that it is impossible to earn respect for a discipline in a country where young researchers may not even have access to healthcare security and pension schemes. Governmental awareness is necessary here to make sure that research activities are sufficiently respected from a very early stage.

VII. Further Information

More details with regards to the Spanish Systems Engineering Association can be found in the following webpage:

http://www.aeis-incose.org

A snapshot is available below in Fig. 20.

Fig. 20: Spanish Systems Engineering Association webpage (http://www.aeis-incose.org)

The Spanish Systems Engineering Association webpage has offered already the following events:

- Constitution act
- First event of the chapter
- Strategies of Design in Great Industrial Interdisciplinary Projects
- Introduction Course to Engineering Systems
- System Dynamics Course
- South European Systems Engineering Tour

It is backed by the Spanish Royal Academy of Engineering. As it can be seen within this list, it is the aim of the Spanish Systems Engineering Association to foster systems thinking in general, which is derived from General System Theory. That is the reason why System Dynamics is also made available to associates willing to learn more about other implications of General System Theory apart from Systems Engineering.

Some snapshots of the courses offered by the Spanish Systems Engineering Association are depicted below in Fig.21, Fig. 22, and Fig. 23. Further information, however, is available in the appendix below.

Fig. 21: South European Systems Engineering Tour (http://www.aeis-incose.org/SESE)

Fig. 22: I Systems Engineering Working Day (http://issuu.com/sociedadaeronautica/docs/sistemas_incose)

Fig. 23: Systems Engineering in Defence (http://www.infodefensa.com/)

APPENDIX: SPANISH SYSTEMS ENGINEERING ASSOCIATION WEBPAGE SNAPSHOTS

International Council on Systems Engineering (INCOSE) es una organización internacional sin ánimo de lucro, fundada en 1990 con el fin de desarrollar y difundir los principios y prácticas interdisciplinares para la realización satisfactoria de sistemas.

La **Asociación Española de Ingeniería de Sistemas (AEIS)**, establecida según la ley 30/1992 tiene la representación oficial de **INCOSE** en España desde 2014, además dentro de la estructura internacional de **INCOSE**, tiene su reconocimiento formal como "**Spanish Chapter of INCOSE**".

AEIS tiene sede en la Real Academia de Ingeniería en la Calle Don Pedro, 10 en Madrid, con la que existe un convenio marco de colaboración, para promover conjuntamente la Ingeniería de Sistemas en España.

AEIS al igual que **INCOSE** tiene :

Misión

- Compartir, promover y avanzar en la mejora de la Ingeniería de Sistemas en todo el mundo para el beneficio de la humanidad y el planeta.

Visión

- Ser la autoridad en el mundo en la Ingeniería de Sistemas.

Objetivos

- Ser el punto de encuentro para la difusión de los conocimientos de Ingeniería de Sistemas.
- Promover la colaboración internacional en la práctica de la Ingeniería de Sistemas, su educación y su investigación.
- Asegurar el establecimiento de los más altos y competitivos niveles profesionales en la práctica de la Ingeniería de Sistemas.
- Conseguir la mejora en la carrera profesional de todas las personas que se dedican a la práctica de la Ingeniería de Sistemas.
- Fomentar el apoyo gubernamental e industrial de programas educativos y de investigación con el fin de mejorar el proceso de Ingeniería de Sistemas y su práctica.

Fig. 24: Start (http://www.aeis-incose.org)

El objetivo prioritario de la ingeniería del siglo XXI es ofrecer a la sociedad productos sostenibles y eficientes, siendo el mayor reto obtener soluciones que equilibren los aspectos humanos, económicos, técnicos, tecnológicos y medioambientales. Entre ellos se pueden enumerar: automóviles, aviones, trenes, barcos, satélites, aeropuertos, sistemas de tráfico aéreo, presas, centrales nucleares, puentes, sistemas militares, etc.

La forma de entenderlos es mediante su representación como sistema, un conjunto de partes interrelacionadas, que interactúan unas con otras de una manera organizada hacia un propósito común. El mayor reto es dar respuesta a la complejidad de los sistemas actuales que desarrolla el hombre, y la Ingeniería de Sistemas proporciona el marco para gestionar estos desafíos:

- Dificultad para identificar las necesidades o problemas reales a resolver, las alternativas de solución, y de entre estas la óptima.
- Garantizar los plazos y costes en los límites deseados de la solución a implementar.
- La gestión, comunicación y colaboración de las empresas, organizaciones y equipos que van a desarrollar, utilizar y a mantener el sistema.
- La extensión temporal la operación de los sistemas complejos se prolonga durante décadas, y en su diseño debe estar prevista la evolución del entorno, y la protección contra la obsolescencia.

Para ello la Ingeniería de Sistemas está dotada de dos aspectos inseparables e inherentemente complementarios. Por un lado un enfoque sistémico para concebir problemas complejos, que permite entender el sistema de interés como uno todo. Y por otro lado un conjunto de procesos sistemáticos que la dota de una aproximación exhaustiva y ordenada para resolverlos.

Fig. 25: Systems engineering (http://www.aeis-incose.org)

Bernardo Delicado – *Presidente*

bernardo.delicado at aeis-incose.org

Ingeniero de Sistemas en la industria aeroespacial con muy dilatada experiencia en múltiples programas internacionales de desarrollo. Ha tenido múltiples y variadas responsabilidades técnicas, siendo un gran conocedor del diseño interdisciplinar, y del ciclo de vida completo de los sistemas aeroespaciales.

http://lnkd.in/vp5F_h

Juan Llorens – Director Técnico y Vicepresidente

juan.llorens at aeis-incose.org

http://es.linkedin.com/pub/juan-llorens/b/857/632

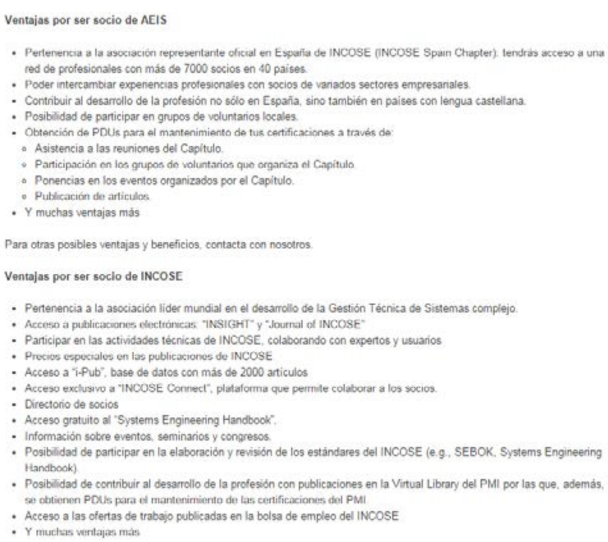
Fernando Mijares – Secretario, Tesorero y Presidente Electo

fernando.mijares at aeis-incose.org

Ingeniero de Sistemas, CSEP, con amplia experiencia internacional en el desarrollo de sistemas complejos en el campo aeroespacial. Distintas responsabilidades técnicas en varios programas le han permitido ampliar su conocimiento del ciclo de vida y de gestión de la complejidad. Complementa su desarrollo profesional con ponencias en distintos cursos y máster. Ha recibido varios premios internacionales relacionados con la Ingeniería de Sistemas, como el CASSIDIAN Engineering Award y el ICAS Von Karman for International Cooperation.

http://es.linkedin.com/pub/fernando-mijares-gordún/2b/668/b94/

Fig. 26: Who we are
(http://www.aeis-incose.org)



Ventajas por ser socio de AEIS

- Pertenencia a la asociación representante oficial en España de INCOSE (INCOSE Spain Chapter): tendrás acceso a una red de profesionales con más de 7000 socios en 40 países.
- Poder intercambiar experiencias profesionales con socios de variados sectores empresariales.
- Contribuir al desarrollo de la profesión no sólo en España, sino también en países con lengua castellana.
- Posibilidad de participar en grupos de voluntarios locales.
- Obtención de PDUs para el mantenimiento de tus certificaciones a través de:
  - Asistencia a las reuniones del Capítulo.
  - Participación en los grupos de voluntarios que organiza el Capítulo.
  - Ponencias en los eventos organizados por el Capítulo.
  - Publicación de artículos.
- Y muchas ventajas más

Para otras posibles ventajas y beneficios, contacta con nosotros.

Ventajas por ser socio de INCOSE

- Pertenencia a la asociación líder mundial en el desarrollo de la Gestión Técnica de Sistemas complejo.
- Acceso a publicaciones electrónicas: "INSIGHT" y "Journal of INCOSE"
- Participar en las actividades técnicas de INCOSE, colaborando con expertos y usuarios
- Precios especiales en las publicaciones de INCOSE
- Acceso a "i-Pub", base de datos con más de 2000 artículos
- Acceso exclusivo a "INCOSE Connect", plataforma que permite colaborar a los socios.
- Directorio de socios
- Acceso gratuito al "Systems Engineering Handbook".
- Información sobre eventos, seminarios y congresos.
- Posibilidad de participar en la elaboración y revisión de los estándares del INCOSE (e.g., SEBOK, Systems Engineering Handbook)
- Posibilidad de contribuir al desarrollo de la profesión con publicaciones en la Virtual Library del PMI por las que, además, se obtienen PDUs para el mantenimiento de las certificaciones del PMI
- Acceso a las ofertas de trabajo publicadas en la bolsa de empleo del INCOSE
- Y muchas ventajas más

Fig. 27: Services
(http://www.aeis-incose.org)

Fig. 28: Collaborators
(http://www.aeis-incose.org)

(Septiembre, 2014)	SESE2014 South European Systems Engineering Tour - SESE 2014
(Durante 2014)	Curso de Dinámica de Sistemas Curso Superior en Modelos de Simulación - CSMS 2014
(Noviembre, 2013)	Curso de Introducción a la Ingeniería de Sistemas La Real Academia de Ingeniería organiza un curso sobre Ingeniería de Sistemas en Defensa y Seguridad
(Abril, 2013)	Estrategias de Diseño en Grandes Proyectos Industriales Interdisciplinares Programa de radio UNED sobre estrategias de diseño en grandes proyectos industriales interdisciplinares
(Diciembre, 2012)	Primer evento del capítulo I Jornada de Ingeniería de Sistemas
(Junio, 2012)	Acto Constitución Constitución del International Council on Systems Engineering (INCOSE) en España

Fig. 29: Events
(http://www.aeis-incose.org)

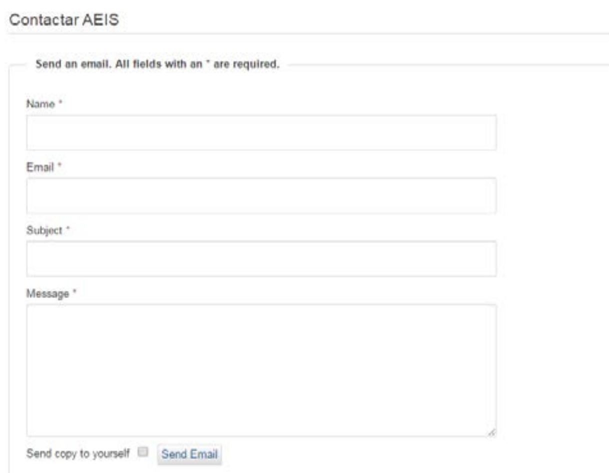


Figure 1: Contact
(http://www.aeis-incose.org)

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Mr. Arias is a member of IEEE and INCOSE. He has chaired a session during the WSEAS 11th International Conference on Engineering Education in Salerno, Italy.