6TH ISRAELI INTERNATIONAL CONFERENCE ON SYSTEMS ENGINEERING
INCOSE IL 2011

Applying holistic thinking to improving your sex life

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ABSTRACT

Optimizing complex systems represents a challenge. Traditional approaches to complex systems development either ignore the issue or optimize subsystems. Some approaches might even iterate through a number of architectures to identify the best one. This paper investigates an alternative approach, namely architecting the complex system to optimize the interactions between the subsystems at design time. The paper uses the interactions in the sex life of males and females (the system) as a case study and shows that better (more pleasurable) results can be achieved by optimizing the system for the interaction at the interface than for the individual (subsystem) experience. The paper then provides diverse examples where systems were or could have been optimized for interactions if seen from the holistic perspective. These instances include weapons systems, logistics systems, the Apollo program, the human cardiovascular system, an online classroom, the INCOSE Australia chapter and a library. The paper concludes with recommendations for further research.

INTRODUCTION

Optimizing complex systems represents a challenge. Allison defines a complex system as "an assembly of interacting members that is difficult to understand as a whole" (Allison, 2004) page 2). Alison further adds that "a system is difficult to understand if an individual cannot understand the details of all members and all interactions between members". No wonder that attempts to create classifications of complex systems are subjective, since some individuals understand things that others do not; complexity is in the eye of the beholder (Jackson and Keys, 1984).

Traditional approaches to systems development tend to either ignore the optimization issue or optimize subsystems after the fact, namely after the subsystem boundaries have been determined. Some approaches to optimizing subsystems even iterate through a number of architectures to identify the 'best' one. This paper uses optimizing your sex life as a basis for hypothesizing and investigating an alternative approach to solving the complex systems optimization problem.

OPTIMIZING YOUR SEX LIFE

Optimizing your sex life is a complex problem and raises several issues mostly not addressed in this paper. For example, in this situation, is each of the participants a system on their own, or are they subsystems of a greater whole? Traditional subsystem optimization approaches would result in an optimization of either the male experience or the female experience[1], while a holistic approach to optimization would seek to optimize the mutual experience by applying holistic thinking to the problem. Holistic thinking is defined as the combination of analysis in the form of elaboration (Hitchins, 2007) pages 93-95), systems thinking and critical thinking (Kasser, 2010). And, as this paper will show, when applied properly, it can produce innovative solutions to difficult problems.

[1] Assuming heterosexual activity in keeping with the traditional view.

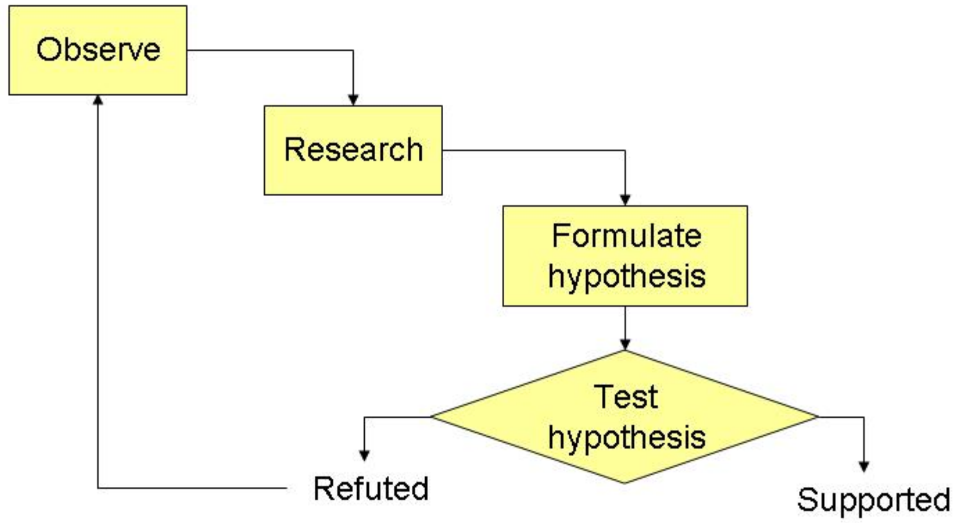

Figure 1 Systems approach to formulating the problem statement, linear representation

In such a situation, the systems engineer could seek to understand the situation using the eight descriptive systems thinking perspectives (Kasser and Mackley, 2008) as a starting point. This is an iterative research situation in the manner of (Hall, 1962) where the systems engineer has to research the application domain to gain an understanding of the situation but is generally shown as a sequential process such as the one in Figure 1. Consider the process steps.

Observe. The systems engineer firsts seeks to gain an understanding of the situation and the relevant issues by observing the situation starting from the eight descriptive systems thinking perspectives and then using active brainstorming sessions (Kasser, 2009) with cognizant stakeholder personnel to generate ideas. In this instance the functional, operational and generic systems thinking perspectives would be good starting points.

Research. The systems engineer would then perform some research via a literature review or further discussions with domain experts to clarify issues or answer questions that came up during the active brainstorming sessions. Some prototyping experiments might also be undertaken to clarify aspects of the situation. The results of the prototyping experiments would be analyzed and further research undertaken if necessary. The research findings might determine that some of the factors are subjective and depend on the person (the subsystem), the time and place (either the environment or as a function of age, length of relationship) or other factors. In such a situation a good systems engineer would list these factors as solution selection criteria and determine ways to identity and weight these factors. It should be noted that this step is often overlooked, and when it is tends to result in the formulation of the wrong problem statement.

Formulate the hypothesis. The next step, assuming a linear sequence, is to formulate the problem statement in the form of a hypothesis (the scientific systems thinking perspective). A problem well stated is a problem half solved (Dewey, 1933) as cited by (Osborn, 1963) page 90). If the problem can be stated as a function, then the solution system is one that provides the needed functionality (Hall, 1989) which can be described in a concept of operations (CONOPS). The first version of a CONOPS, being a representation of the solution system, constitutes a hypothesis for the operation of the solution system. In this instance, the systems engineer would determine the factors that make your sex life enjoyable and what signals need to be exchanged between you and your partner[2] in all interfaces (tactile, audible, visual, etc.) at all times. The systems engineer would work with

[2] Before, during and after the actual sex act.

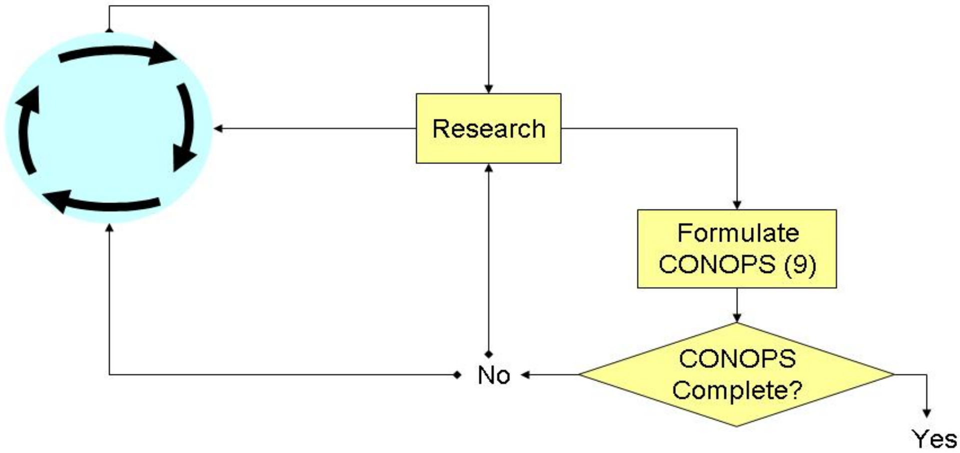

Figure 2 Systems Approach to Formulating a CONOPS

you (and your partner, if available) to develop a CONOPS containing scenarios for the mission and support[3] functions performed in different aspects of your sex life. In other situations facing different problems, different systems engineers, working independently from the first and in parallel, would develop a different CONOPS for different alternative solution systems that provide different acceptable solution to the problem. In this situation, there is a subsequent activity that generates selection criteria for choosing the best CONOPS or combining parts of them into a single optimal CONOPS.

Test the hypothesis. The linear sequence approach teaches that once the hypothesis for the functionality of the solution has been developed in the form of the CONOPS, the hypothesis would be tested. The hypothesis would be tested against solution selection criteria developed in discussions and active brainstorming sessions with the customer and other stakeholder personnel. However, a good systems engineer would keep the customer involved during the process of developing the CONOPS; that is why the systems engineer would work with you to develop the CONOPS. In reality, this is not a linear process, it is a continual process of observation, brainstorming, research and hypothesis formulation (systems thinking) and in-process hypothesis formulation and testing (critical thinking) as shown in Figure 2 so that when completed, the CONOPS represents a feasible and acceptable solution to the problem, and the milestone review held at the end of the lifecycle phase documents:

(1) consensus that the solution is feasible and acceptable and
(2) the decision to proceed to the next phase of the solution system development lifecycle.

Holistic optimization. As stated above, traditional subsystem optimization would tend to result in an optimization of either the male experience or the female experience. The traditional approach might begin by considering one of the parties and optimizing the system to provide maximum pleasure for that party. The holistic approach on the other hand considers both parties as parts of a larger system and optimizes the interactions at the interface for maximum pleasure to both parties. In a really complex system, there may be a number of interfaces such that the individual interfaces may be grouped into a third high-level subsystem. Notice that there may be different subsystem boundaries in the traditional and holistic approaches as shown in the examples that follow. This reminds us of (Kline, 1995)'s dictum that the system is only a representation of the real world, or in today's object-oriented parlance, an abstraction or a view of the real world.

COMPLEXITY

The previous section described a single situation. This paper now looks at complexity to determine if the same approach can be used in other situations. There seems to be two types of complexity (Kasser and Palmer, 2005):

[3] In this instance, the support functions might be concerned with creating the appropriate environment, and ensuring that appropriate consumable supplies are available as and when needed (logistics).

- **Real world complexity** - in which elements of the real world are related in some fashion, and made up of components. This complexity is not reduced by appropriate abstraction it is only hidden.
- **Artificial complexity** – (Maier and Rechtin, 2000) point out, poor aggregation and partitioning during development can increase complexity. Artificial complexity arises from either poor aggregation or including elements of the real world that, in most instances, should have been abstracted out when drawing the internal and external system boundaries, since they are not relevant to the system. It is this artificial complexity that gives rise to complication in the manner of Rube Goldberg or W. Heath Robinson[4]. For example, in today's paradigm, complex drawings are generated that contain lots of information[5] and the observer abstracts information as necessary from the drawings. The natural complexity of the area of interest is included in the drawings. Hence the system is thought to be complex.

REDUCING COMPLEXITY

The key to the holistic approach is based on the statement that complexity is in the eye of the beholder (Jackson and Keys, 1984). So what makes a system complex in the eye of the beholder? According to (Allison, 2004), a system may be perceived as complex by having:

- a large number of members or subsystems (size, scale);
- strong interactions between the subsystems, or
- a combination of the above.

Reducing complexity means making it easier to understand the system which may be achieved by a combination of:

1. Using a small number of subsystems at any level in the hierarchy.
2. Minimizing coupling between, and maximizing cohesion of, subsystems.
3. Configuring subsystems for the maximum degree of homeostasis.

Reducing the number of subsystems at any level in the hierarchy. (Maier and Rechtin, 2000) p 6) recommend that the way to deal with high levels of complexity is to abstract the system at a high a level as possible and then progressively reduce the level of abstraction. (Miller, 1956)'s rule of no more than 7±2 subsystems at any layer in the hierarchy is the target to aim for to facilitate understanding of the system

Minimizing coupling between and maximizing cohesion of subsystems (Ward and Mellor, 1985). At conceptual design time, functional cohesion should be maximized. Physical cohesion will tend to depend on the reliability, maintainability and survivability aspects of the system.

Designing subsystems for the maximum degree of homeostasis. Designing subsystems for the maximum degree of homeostasis will not only facilitate comprehension of the function of the subsystem but enable the subsystem to continue to operate (complete the mission) should the interface fail and command and control be lost. This principle applies to both technological and human subsystems.

The combination applies not only when designing a new system but also when trying to understand an existing system. When designing a new system, the subsystem boundaries flow from functional allocation activities. However, when analyzing an existing system, a high degree of abstract thought may be necessary to determine the subsystem boundaries to employ since they may not be intuitive. The examples shown below demonstrate this concept. However, while reducing the complexity may facilitate understanding, it still does not indicate how to optimize the system.

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[4] Cartoonists in the USA and UK who drew cartoons of complex systems designed to perform simple functions.

[5] DoDAF Operational View (OV) diagrams can provide wonderful examples of artificial complexity.

HOLISTIC HYPOTHESIS FOR COMPLEX SYSTEM OPTIMIZATION

There are many different definitions of a system, see summary in (Kasser and Palmer, 2005) for some examples. These definitions contain or imply there is a relationship or an interaction between the members (components or subsystems) of the system. Consequently, a systems approach may be defined as

> "an approach to problem solving that views any problem as a part of a bigger system, and in developing a solution, sees that solution being achieved through the **interaction of system elements**[6], such that the properties of the whole are beyond the properties of the individual parts"(Halligan, 2010).

This paper now introduces the hypothesis that the holistic approach to optimizing a complex system may be defined as an approach that **optimises** the system for **the interactions between the subsystems** at design time, rather than an approach that optimizes the subsystems after the subsystem boundaries have been determined.

OPTIMIZING FOR INTERACTIONS

The section on optimizing your sex life for the interactions between partners (maximum mutual enjoyment)) provides the insight for the hypothesis that a holistic approach that optimized the complex system for interactions between its subsystems rather than trying to optimize its subsystems would produce a 'better' complex system. Consider how this approach could be used in other situations. (Aslaksen, 2004) writes

> "Our choice of boundaries and interactions depends on what we are trying to understand and what we, as engineers, want to achieve by this understanding, so that system definitions are inherently subjective. In effect, defining a system is the first step in creating a model of some part or aspect of reality".

This section examines situations wherein redrawn system boundaries show that the 'system' can be optimised for interactions. Consider each of the following diverse situations:

- Weapons systems
- The Royal Air Force (RAF) Battle of Britain Air Defence System (RAFBADS)
- Logistics systems
- The Apollo Program
- The MIR space station
- The human cardiovascular system
- A distance learning classroom
- The Library
- Forming the International Council on Systems Engineering (INCOSE) Australia chapter

Weapons systems. Weapons systems are initially designed to perform specific missions. The general goal of a weapons system is to deliver the required amount of something, usually, but not necessarily, ordnance, to the target in a timely manner. The 'required' amount depends on the mission. For example, tanks were originally designed as part of a system that would enable troops to pass safely through territory swept by hostile machine gun fire, specifically the trenches in World War I. From the holistic thinking perspective, let the battlefield be the system and the allied forces and enemy forces be the two major subsystems, then the tank can be considered as an element of the interface between the friend and foe subsystems. The subsystem partitioning is reasonably traditional.

With hindsight, what actually happened (Wikipedia, 2010) can be mapped into the process shown in Figure 2 as if holistic thinking had been employed. The situation could have been analyzed and the system problem defined as the need to break through the enemy front line trenches (swept by machine gun fire which, according to lessons learned from experience, precluded the traditional infantry or cavalry charge from performing the function) so that infantry and cavalry could then be used in their traditional manner to route the enemy after a breakthrough. Various scenarios would have been conceptualized and rejected. Research would have been carried out to see if there was anything appropriate that could be employed. Concepts such as land ships would have been prototyped and various types of tanks evolved together with the tactics for their use. In fact, the lack

[6] Bold text by this author.

of holistic thinking meant that the tank was not effectively integrated into the British forces until the Battle of Amiens which began on 8 August 1918. This was the battle that led to the end of the First World War. However, by then the Germans had learned to deal with tanks. 72% of the Allied Tank Corps was destroyed in the first days of the battle, 41.4% of all British tanks had been destroyed by the 64th day and on November 5th, there were only eight tanks left in the British tank corps (Wikipedia, 2010) Luckily, the tank was not the deciding factor in ending the war. The holistic approach might have produced a better system (integration of tanks, infantry and doctrine) and fewer casualties.

The Royal Air Force (RAF) Battle of Britain Air Defence System (RAFBADS). The RAFBADS was used to foil the Luftwaffe's attempt to gain control of the sky over southern England in 1940.

> "Work on the system began in 1937 and it was still being refined in 1940… … It was a remarkable creation. It brilliantly solved the problems of dealing with massive amounts of data from a wide range of sources in a very short time and using it to exercise control over the fighting. It was a system for managing chaos. Its intelligence gathering capability extended to the period after an engagement, enabling Dowding and his generals to blow away the fog of war very quickly. It possessed a Defence Teleprinter Network (DTN) connecting all RAF stations and Headquarters. After raids, the DTN was full of information gathered from returning pilots in de-briefs as well as from those who stayed on the ground. As a result 'loss details, combat reports, ground damage reports, casualties, aircraft and equipment requirements were easily disseminated throughout the whole system'. Its fundamental excellence and its ultimate success in practice can be attributed to a number of features.
>
> Firstly, its operational structure was simple and roles were very clear. Everyone knew what they had to do. It was not parsimonious with information: plot data was shared widely and passed simultaneously to several levels at once. Bentley Priory gave out information simultaneously to groups and sectors and sectors could plug into local Observer Groups once they knew something was up in their area. It was in effect an analogue intranet. Whilst it was used to transmit orders down the chain of command, it was also designed to allow anybody in the system to find out what they wanted when they wanted it from anybody else. It was a network organization based on telephone lines rather than e-mail" (Bungay, 2000) page 64).

Let the battle space be the system and the RAF and Luftwaffe be the subsystems. In the holistic view, the subsystem partitioning was as follows. The RAF comprised the organisational structure, the logistics and support systems that supply aircraft, pilots, fuel, ordnance, etc. to the fighter airfields. The airfields were not part of the RAF subsystem. The Luftwaffe subsystem performed similar functions supporting their fighter and bomber aircraft and included their airfields. The RAFBADS, shown in Figure 3 comprised the interface between the RAF and Luftwaffe subsystems. The RAFBADS contained the RAF fighter airfields and aircraft, and the sensors and command and control links that vectored the fighters to meet the Luftwaffe intruders (Checkland and Holwell, 1998). In this instance, the RAFBADS was a complex interface and can be considered as a subsystem of the battle space.

The RAFBADS was optimized to vector RAF fighter aircraft to the vicinity of the Luftwaffe invaders to provide the maximum amount of engagement time while conserving RAF fighter resources (Bungay, 2000). The evolution of the design of the subsystems within the RAFBADS such as the RADAR and Observer Corps can be mapped into the process shown in Figure 2. The design of these two subsystems also complied with the rules for reducing complexity and was optimized to pass information and fighter aircraft across the respective interfaces in a timely manner. From this perspective, with hindsight, the RAFBADS provides an example of holistic complex system optimization at several layers in its hierarchy.

Logistics systems. Once total cost of ownership (TCO) and life cycle costing (LCC) were taken into account at system design time, logistic systems were generally designed to support the mission and deliver optimal support to the operational system. The holistic two subsystem model can be applied to this situation; the subsystems being the mission subsystem and the support subsystem. However unlike the traditional subsystem partitioning, in the holistic view, the maintenance functions and associated equipment are part of the interface (subsystem).

In the holistic view, it is the interface (subsystem) between the mission and support subsystems that keeps the mission functions operational. In many situations, once the CONOPS for the mission and support functions has been developed, the system is optimized for maximum Operational Availability of the operational subsystem. The tradeoffs to optimize the Operational Availability of the mission system at design time deal with reliability, failure rates, failure modes and failure consequences, mean time to repair, etc. At the interface subsystem this is equivalent to reducing down time by increasing system reliability and reducing the mean time to repair failures.

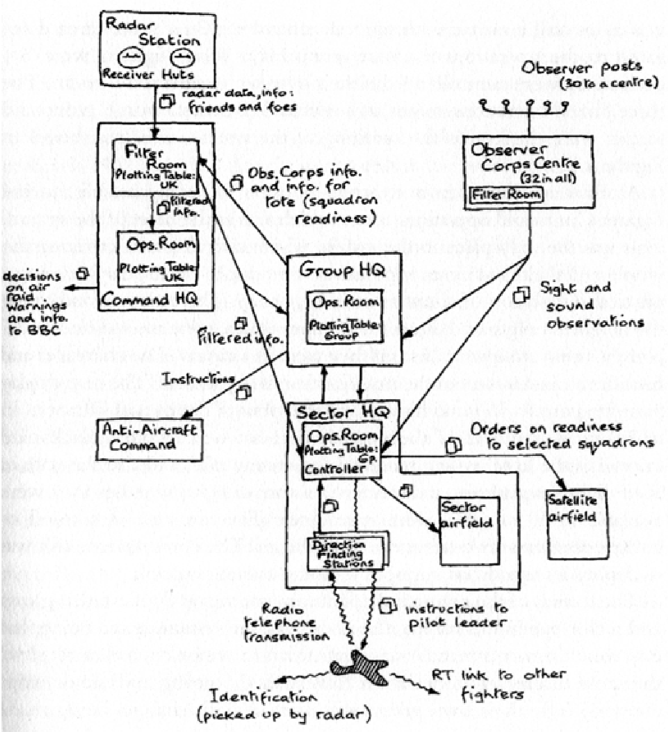

Figure 3 The RAFBADS (Checkland and Holwell, page 135)

The Apollo Program was a major systems engineering success. From the holistic perspective, consider the Apollo program as the system, the Moon and the Earth as subsystems and a complex interface system between the Earth and lunar subsystems. The Earth subsystem contained the National Aeronautics and Space Administration (NASA) manned spacecraft centers; the lunar subsystem was void before the first landing and then contained the Apollo Lunar Surface Experiments Packages (ALSEP), the set of scientific instruments deployed by the astronauts at each of the landing sites. The interface subsystem contained spacecraft and communications subsystems.

From this perspective, the Apollo program seems to have been optimized to transfer men between the Earth and the moon in the most efficient manner within the constraints of the then available technology. This resulted in a manually intensive complicated but understandable Earth subsystem. Unfortunately this subsystem arrangement was perpetuated into the post Apollo era for various reasons resulting in a minimally reusable overly expensive space transportation system.

The MIR space station. MIR was a Soviet/Russian space station in low Earth orbit from 1986 to 2001. When faced with the problem of resupplying MIR, the subsystem boundaries remained the MIR, the Earth and the interface. The system was optimized for the delivery of personnel and cargo to MIR, personnel being delivered by manned vehicles and cargo mainly by unmanned autonomous vehicles. Simple, readily understandable and effective!

The human cardiovascular system delivers oxygen to the muscles in the human body. Here the system can be represented by the lung subsystem which oxygenates the blood, the muscles subsystem and the heart and blood vessels which comprise the bulk of the interface to the muscles subsystem.

A distance learning classroom. The distance learning classroom at Missouri University of Science and Technology (MS&T) for SysEng 412 Complex Engineering Systems Project Management in the Fall 2010 semester was a complex system. The traditional system view might have organised the subsystems as:

- a face-to-face classroom at MS&T equipped with the appropriate synchronous technology for including distant students in the learning process,
- the students in the face-to-face classroom[7],
- a synchronous distance learning classroom using the Webex platform,

[7] There weren't any in this instance.

- an asynchronous distance classroom using the Blackboard 9 platform,
- the distance mode students in the USA,
- the instructor in Singapore,
- the email system for asynchronous communications, and
- the real-time support staff at MS&T. Note, support was available online during each weekly session and offline in non-real time with a timely response.

On the other hand, the holistic perspective partitions the system into two subsystems and an interface system. The subsystems are the instructor and the students; the classrooms and other facilities comprise the interface subsystem. The system was designed to optimize the learning experience based on the needs of postgraduate employed students studying in their spare time (Kasser, et al., 2008). The design of this iteration of SysEng 412 included a mixture of lectures, readings and problem based learning activities using both synchronous and asynchronous activities. When the semester began, the study materials were loaded into Blackboard for asynchronous downloading prior to the weekly Webex synchronous session. The lecture was given synchronously; the students worked together synchronously and asynchronously and made a synchronous presentation in the weekly Webex synchronous session. However, a week or so after the semester began an anomaly showed up in the synchronous lectures. The instructor's Webex audio suffered from distortion that made it unintelligible according to some but not all students. Upon enquiring about the situation, the support staff acknowledged that this was a recurring problem when the instructor was located outside the United States.

The interface system was quickly redesigned to keep the learning experience optimal. Subsequent lectures were pre-recorded as an MP3 voice quality bandwidth audio file and uploaded to the Blackboard area for the specific session together with the lecture slides. The students downloaded the lecture audio file together with the lecture slides and listened to the lecture asynchronously prior to the Webex synchronous session. The redesigned faced a delivery domain problem due to the differences between synchronous and asynchronous lectures (Kasser and Day, 2000). The major one being that the students cannot ask questions in an interactive synchronous manner. This drawback was overcome using domain knowledge in the following manner.

1. The instructor would cue the students to change slides using wording such as "and on the next slide". Additionally, every now and again during the talk, the instructor would mention the slide number as synchronization signal. At the appropriate points in the lecture where the instructor would pause and ask for questions, an 'any questions slide' was inserted into the lecture slides. The questions were posed asynchronously and a comment was added to each question that answers would be provided in the interactive session.
2. The asynchronous lecture was reformatted to allow for multiple threads so that later content did not depend on a previous discussion in the same session (Kasser and Day, 2000).
3. During the interactive synchronous session, the instructor paged through the lecture slides summarizing the lecture, sometimes adding additional information and always stopping at the appropriate places for questions and comments.

The students soon caught on to the idea and the end result was a shortened synchronous session which allowed the students to spend more time on the problem based learning activities (even more optimal). Indeed the system was flexible enough so that on one occasion when the instructor was travelling to a conference at the exact time the synchronous session was due to take place, the pre-warned students were able to prepare and upload asynchronous presentations to Blackboard and the whole session took place asynchronously (presentations and post presentation dialogue (questions and comments)) in Blackboard.

The Library. The library-patron system provides desired information (books, journals, and publications) sourced in, or obtained by, the library subsystem to patron subsystem. Libraries have been optimizing the interface delivery for years finding newer and better ways to provide patrons with the desired information. Librarians call this providing better service.

Forming the INCOSE Australia chapter. After the Memorandum of Understanding (MOU) between the INCOSE and the Systems Engineering Society of Australia (SESA) expired in 2004, the members of SESA attending its annual general meeting voted that SESA not become a chapter of INCOSE and remain an independent organization. This left a situation in which there was a desire and support for a chapter of INCOSE in Australia, while at the same time the overwhelming majority of Australian systems engineers wanted a single professional organisation for systems engineers in Australia and feelings were running high on the issue. The innovative solution was to constitute a chapter of INCOSE in Australia, INCOSE-Australia as *a special interest group within SESA*. This solution:

1. Avoided a "civil war" within the systems engineering profession in Australia.
2. Meant that nobody could join INCOSE-Australia without being a member of both INCOSE and SESA.
3. Allowed those SESA members who desired INCOSE services and products to obtain them without having to join two professional societies;
4. Allowed those systems engineers that did not desire the INCOSE products and services to be part of SESA.

Australia has a single systems engineering professional society within the Engineers Australia constituency namely SESA. However, as far as INCOSE is concerned there are two systems engineering professional societies in Australia. In the traditional view, the two societies may be viewed as subsystems of the systems engineering community in Australia (the system). The innovative solution was made possible by considering SESA as containing the following non-traditional three functional subsystems:

1. INCOSE Australia which constituted the members of SESA who were also members of INCOSE
2. The remaining non-INCOSE membership of SESA.
3. The SESA Headquarters which received the dues payment from INCOSE

The system was optimized for minimal interface activity on the interfaces between the subsystems. Thus Australian systems engineers who wished to be part of INCOSE paid their membership dues to INCOSE directly just like any other regular INCOSE member anywhere else in the world. INCOSE then bulk refunded a portion of the dues to INCOSE Australia but made the payment directly to SESA; the refunded portion covering the membership dues for SESA. The single individual dues payment to INCOSE provided membership of both organizations. In addition, INCOSE Australia did not need a bank account as INCOSE Australia incurred no costs since all professional systems engineering society activities in Australia were SESA activities by definition. The only information that needs to be exchanged at the interface between the INCOSE Australia and SESA is the list of INCOSE Australia members that is passed to SESA for the purpose of providing mailing labels for the quarterly SESA newsletter. As a serendipitous benefit,

1. SESA has the advantage of autonomy from INCOSE and does not have to conform to any INCOSE rules and regulations.
2. The elected officers of INCOSE Australia have little to do on behalf INCOSE Australia other than remembering to hold the required annual general meeting[8]; in particular there is nothing for the treasurer to do.

THE GENERIC MODEL

The generic model discussed in examples in the previous section is compliant with the rules for reducing complexity discussed above.

1. The number of subsystems is small, namely two, three if the interface between the two major subsystems is complex enough to be considered as a subsystem. This facilitates understanding of the system.
2. The cohesion of each subsystem is maximized and the coupling is minimized.
3. The subsystems are designed for homeostasis.

The system is optimized by designing the subsystems to optimize the interactions at the interface between the major subsystems. This model seems to be self-similar and should apply to any level in the system hierarchy. The RAFBADS complies with this model at any level in its hierarchy. In each of the examples discussed above, even though the systems are complex, understanding the system functionality is reasonably straight forward. This is because the functionality of each subsystem can be understood as can the interactions at the interface.

[8] All professional systems engineering society activities with Australia are SESA activities by definition.

In some of the examples discussed above the subsystem boundaries were traditional, in others they there were non-traditional. The tank development can be mapped into the holistic approach but the development wasn't holistic and the results were less than optimal. The objective was achieved but the price in loss of lives and materiel was higher than it could and should have been. The holistic approach to designing a system is a slightly different approach from that currently employed. It is a structured hierarchical approach to design and analysis. The functional allocation of the CONOPS is mapped into two major subsystems and an interface (subsystem) between them. The functional subsystems are then optimized so that the mission functions take place in an optimal manner in the interface (subsystem) between the major subsystems.

Domain knowledge, both application and implementation, is a critical element in the holistic approach to optimizing complex systems. The systems engineer uses the domain knowledge to visualize a conceptual two subsystem and optimized interface implementation of the CONOPS. This observation brings us back to (Allison, 2004)'s definition of a complex system as "an assembly of interacting members that is difficult to understand as a whole". When one understands the system by virtue of the appropriate domain knowledge, the system is no longer complex.

It was an analysis of the holistic approach to improving your sex life that provided the insight to create the two subsystems and optimal interface approach to optimizing complex systems. Use of the approach should also provide an indirect improvement – not worrying about how to understand and optimize complex systems should reduce stress and improve your sex life.

SUMMARY

This paper investigated a holistic approach to understanding and optimizing complex systems so as to optimize the interactions between the subsystems. The paper used the interactions between males and females (the system) as a case study and showed that better results can be achieved by optimizing the system for interaction than for the individual (subsystem) experience.

The paper then provided diverse examples where via the use of domain knowledge, systems were optimized for interactions if seen from the holistic perspective. These instances included weapons systems, logistics systems, the Apollo program, the human cardiovascular system, a distance learning classroom and a library. The paper concluded with comments on a generic holistic optimization approach for complex systems based on a two subsystem and interface model.

CONCLUSION

The traditional approach to optimizing complex systems is based on performing the optimization after the system has been partitioned into subsystems. The generic holistic optimization approach for complex systems optimization performs the optimization as part of the system design and looks promising. However, apart from the distance learning classroom and INCOSE Australia cases which used this approach, the other analyses have been made with hindsight.

The holistic optimization approach requires an understanding of the situation domain to succeed, which makes the system less complex and easier to fully understand.

Further research is needed to explore and refine the concept.

BIOGRAPHY

Joseph Kasser has been a practicing systems engineer for 40 years and an academic for about 10 years. He is a Fellow of the Institution of Engineering and Technology (IET), an INCOSE Fellow, the author of "A Framework for Understanding Systems Engineering" and "Applying Total Quality Management to Systems Engineering" and many INCOSE symposia papers. He is a recipient of NASA's Manned Space Flight Awareness Award (Silver Snoopy) for quality and technical excellence for performing and directing systems engineering and other awards. He holds a Doctor of Science in Engineering Management from The George Washington University. He is a Certified Manager and holds a Certified Membership of the Association for Learning Technology. He has also served as the inaugural president of INCOSE Australia and as Region VI Representative to the INCOSE Member Board. He gave up his positions as a Deputy Director and DSTO Associate Research Professor at the Systems Engineering and Evaluation Centre at the University of South Australia in early 2007 to move to the UK to develop the world's first immersion course in systems engineering as a Leverhulme Visiting Professor at Cranfield University. He is currently a Visiting Associate Professor at the National University of Singapore.

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