Midwest Gateway Newsletter

INTERNATIONAL COUNCIL ON SYSTEMS ENGINEERING

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In This Issue

Editor: **Bob Scheurer** **314/234−1608** **rscheurer@mdc.com**

Chapter Business

1997 Programs

by John P. Adrian, Programs Chair

So far this year we have had three successful programs:

• *Seven Questions For Penetrating Technical Fog* − Bill Schoening of McDonnell Douglas and INCOSE Central Office President−Elect

• *The Bottom Line on Systems Engineering Processes* − Jim Cloud of Motorola

• *Everything I Needed To Know About Teamwork, I Learned In Kindergarten... And Can Do With Notes!* − Al Vigland of IBM Global Services

Although the attendance at these meeting has not been what I expected, the attendees have been pleased with the breath of topics and information presented.

Since June and July are vacation months, we will not schedule a formal program during these months. The next program will be scheduled in the August time frame and will be a review of the happenings of INCOSE 97 in Los Angeles. Keep an eye out for the program announcement flyer in early August.

I still need your involvement and input. Let me know what type of programs you want and let me know why you're not coming to the programs (cost, time, location, days of the week, etc.). In addition, I have had several people tell me that they like the idea of a "Community Outreach Program;" however no one has agreed to help initiate one. If you are interested give me a call at 314−233−2755 or drop me a note at jadrian@mdc.com.

Membership Diversity

by Carol Wilke, Director

A recent survey of the membership rolls for the Midwest Gateway Chapter indicates that we have 85 total members, representing 29 different employers (including two universities, three branches of the armed forces, several commercial electronics makers, various defense contractors and others), spread over 7 different states (IL, IN, IA, KS, MO, NE, TN).

Chapter Web Site

by Bob Scheurer, President−Elect

The Midwest Gateway Chapter web site moved in April to a new web server sponsored by the University of Illinois. It can now be found at the URL:

http://www.aae.uiuc.edu/incose/

When visiting, users will find the latest Midwest Gateway Newsletter, information about INCOSE, links to sites with Systems Engineering content, and more. Make a note of the change and watch the site for breaking news about your local chapter.

InterNational NewsWatch

Central Office Perspective

by Bill Schoening, President−Elect, INCOSE Central Office

The 1997 INCOSE Membership Directory is available to members for downloading from the INCOSE Web site. You will need a password to unpack the data. The password is can be obtained from the central office by calling 800−366−1164 or sending email to incose@halcyon.com. Please provide your name and membership number to facilitate checking your membership before providing you with the password.

If you haven't looked at the INCOSE web site recently, take a look at www.incose.org. New information is being uploaded on a regular basis. As soon as we obtain our own server, the cycle time between submittal of new information and appearance on the web site will go down substantially.

We had delayed an official announcement of locations of future symposia; we were awaiting the resolution of several items. Unfortunately, the summer issue of INSIGHT went to press before the announcement was formalized. As you know, the 1997 Symposium is in Los Angeles this August. We will be in Vancouver, B.C. in 1998, Brighton, England in 1999, Minneapolis, MN in 2000, and Australia in 2001. I am personally very excited about the international lineup to support our burgeoning international membership. We are looking for more regional INCOSE symposia in 1999 and 2001 in North America, just as there have been regional symposia in Europe and Australia.

International activities are a challenge, just as the April Board of Directors meeting was a challenge. Two groups met via video conference between Seattle, WA and Melbourne, FL with Robert Halligan telephoning in from Australia after midnight and Peter Brook from London, England in the late evening. We are working hard to revise the way we do business as a Board so we can concentrate on the real issues that affect members. It is a learning experience for all of us, and we are doing better. (Each of us is also learning better ways to conduct business in our own companies.) Following our usual Board meeting at the Symposium, we will have another in the fall. (Lest you thing the meetings are a lark, we try to review all the material in advance, pack as much decision making and related debate into 8 hours as we can, and fund the trip either through our companies or on our own.)

As we grow and change, the folks who support us change over time. We asked for bids for of symposium manager, and PCMI with Cass Jones as president will be our new symposium manager beginning with Brighton England in 1999. Richard Schwadron, chair of the 1995 Symposium in St. Louis and an active member of the INCOSE standing symposium committee, has completed negotiations for the new contract with PCMI. Ellen Barker and Engineer Professional Systems did a wonderful job for INCOSE during these early years. They had a great deal to do with the success of the St. Louis Symposium, and we will miss them.

Of growing interest are the Strategic Plan and its implementation − the Technical Operating Plan. The former can be viewed on the INCOSE web site. The latter is 5−year plan of action intended to address the issues and needs identified in the Strategic Plan. These plans addresses all the key topics essential to the health (namely, its members, chapters, and technical products) of INCOSE. As we get a little farther along with the Technical Operating Plan, we will put it on the web as well.

Don't Forget:

The ISO/IEC 12207 definition for System is:

"An integrated composite that consists of one or more of the processes, hardware, software, facilities and people, that provides a capability to satisfy a stated need or objective."

Feature Article

"Pragmatic Principles" of Systems Engineering

by Beth Clark

I have taken the liberty of listing the "INCOSE Pragmatic Principles of Systems Engineering.". I'm interested in what you all think: do these principles hold true in the environment in which you practice systems engineering?

This list is abstracted from a report edited by Joe DeFoe and compiles a set of "pragmatic principles" that underlie the practice of systems engineering. The lists in this document consolidate the contributions from the INCOSE members who participated in the ex-

ercise that produced the original list and in the review of the draft document. Each item represent a principle that has either, when heeded, aided the member in practicing successful systems engineering or, when ignored, led to difficulties. The starting point for the exercise was the definition of systems engineering contained in the May 15, 1991 Pre−coordination Draft of Mil−STD−499B Systems Engineering:

Systems engineering is an interdisciplinary approach to evolve and verify an integrated and optimally balanced set of product and process designs that satisfy user needs and provide information for management decision making.

1. KNOW THE PROBLEM, THE CUSTOMER, AND THE CONSUMER

1. Become the "customer/consumer advocate/surrogate" throughout development and fielding of the solution.

2. Begin with a validated customer (buyer) need − the problem.

3. State the problem in solution−independent terms.

4. Know the customer's (buyer's) mission or business objectives.

5. Don't assume that the original statement of the problem is necessarily the best, or even the right one.

6. When confronted with the customer's need, consider what smaller objective(s) is/are key to satisfying the need, and from what larger purpose or mission the need derives; that is, find at the beginning the right level of problem to solve.

7. Determine customer priorities (performance, cost, schedule, risk, etc.).

8. Probe the customer for:

• new product ideas

• product problem/shortfall identification

• problem fixes

9. Work with the customer to identify the consumer (user) groups that will be affected by the system.

10. Use a systematic method for identifying the needs and solution preferences of each consumer group.

11. Don't depend on written specifications and statements of work. Face to face sessions with the different customer/consumer groups are necessary.

12. State as much of the each need in quantified terms as possible. However, important needs for which no accurate or quantified measure exists, still must be explicitly addressed.

13. Clarify each need by identifying the power and limitations of current and projected technology relative to the customer's larger purpose, the environment, and ways of doing business.

2. USE EFFECTIVENESS CRITERIA BASED ON NEEDS TO MAKE SYSTEM DECISIONS

1. Select criteria that have demonstrable links to customer/consumer needs and system requirements.
a. Operational criteria: mission success, technical performance.

b. Program criteria: cost, schedule, quality, risk.

c. ILS criteria: failure rate, maintainability, serviceability.

2. Maintain a "need based" balance among the often conflicting criteria.

3. Select criteria that are measurable (objective and quantifiable) and express them in well know, easily understood units. However, important criteria for which no measure seems to exist, still must be explicitly addressed.

4. Use tradeoffs to show the customer the performance, cost, schedule, and risk impacts of requirements and solutions variations.

5. Whenever possible, use simulation and experimental design to perform tradeoffs as methods that rely heavily on "engineering judgement" rating scales are more subject to bias and error.

6. Have the customer make all value judgements in tradeoffs.

7. Allow the customer to modify requirements and participate in the developing the solution based on the tradeoffs.

3. ESTABLISH AND MANAGE REQUIREMENTS

1. Identify and distinguish between specified (fundamental or essential), allocated, implied and derived requirements.

2. Carry analysis and synthesis to at least one level broader and deeper than seems necessary before settling on requirements and solutions at any given level. (Top−down is a better recording technique than it is an analysis or synthesis technique.)

3. Write rationale for each requirement. The attempt to write rationale for a "requirement" often uncovers the real requirement.

4. Ensure the customer and consumer understand and accept all the requirements.

5. Explicitly identify and control all the external interfaces the system will have − signal, data, power, mechanical, parasitic, etc. Do the same for all the internal interfaces created by the solution.

6. Negotiate interfaces with affected engineering staff on both sides of each interface and get written agreement by the two parties before the customer approves the interface documentation.

7. Document all requirements interpretations in writing. Don't count on verbal agreements to stand the test of time.

8. Plan for the inevitable need to correct and change requirements as insight into the need and the "best" solution grows during development.

9. Be careful of new fundamental requirements coming in after the program is underway. They invariably have a larger impact than is obvious.

10. Maintain requirements traceability.

4. IDENTIFY AND ASSESS ALTERNATIVES SO AS TO CONVERGE ON A SOLUTION

1. Take the time to innovate by generating a wide range of alternative solutions to satisfy the need. (A common mistake is to converge on a "comfortable design" concept too early because of time constraints.)

a. Consideration of seemingly bizarre alternatives often yeilds additional insight into the requirements and provides a reasonableness check for tradeoff criteria and weights.

b. Include the "do nothing solution" in the system level solution tradeoff to provide a measure of the value−add the new system will bring the customer/consumers.

2. Use a systematic architecture/design method.

a. Abstract the requirements to identify the essential design problems.

b. Establish functional structures.

c. Search for solution principles to fulfill the sub−functions.

d. Combine the solution principles to fulfill the overall functions.

e. Select suitable combinations

f. Firm combinations into conceptual alternatives.

3. Evaluate each alternative against the requirements and the effectiveness criteria. Determine the alternative that provides the best weighted value combining:

- effective
- efficient
- safe
- reliable
- producible
- testable
- maintainable
- easiest to learn

4. Elaborate the customer's top−level concept of operations to show how the consumers will use each solution alternative to satisfy the consumers and the the customer's needs. This detailed concept of operations must be reflective of the design aspects of the system's operation.

5. VERIFY AND VALIDATE REQUIREMENTS AND SOLUTION PERFORMANCE

1. Quality must be designed in, it cannot be tested in.

2. Use preplaned peer reviews and inspections.

3. Prototype critical elements.

4. Use models to demonstrate feasibility before bending metal and writing code.

5. Explicitly identify and check all model assumptions.

6. Work the critical and controversial requirements and design areas first.

7. Plan the verification and validation for every requirement.

8. State Know the expected results before testing.

6. MAINTAIN THE INTEGRITY OF THE SYSTEM

1. Maintain a systems engineering presence throughout the program (even though SE staff starts to drop off after PDR and more after CDR) to provide technical oversight of the ongoing design process and to resolve requirements/technical issues that invariably arise, including resolution of test discrepancies/anomalies.

2. Prevent process and product contamination.

3. Ensure the system design meets the requirements, satisfies the need, and reflects the voice of the customer.

4. Ensure the requirements address not only the operational objectives but all the life−cycle objectives for the system.

7. USE AN ARTICULATED AND DOCUMENTED PROCESS

1. Start with established principles – avoid reinventing the wheel and really learn from "lessons learned" investigations.

2. Use the principles to develop a process tailored to the need, the system, the customer, and the development organization.

3. Use the process consistently across the program.

4. Train the development staff in the process and its application – technical education is one key to productivity, quality, and cost reduction.

5. Use standardized analysis techniques, document formats, design review formats, etc. to reinforce the consistent application of the process.

6. Use readily available automated tools wherever appropriate.

7. Maintain process integrity but never let the process prevent the "best" solution from being discovered or used – do whatever it takes to build in product quality.

8. MANAGE AGAINST A PLAN

1. Use a "tasks are executed to produce useful work products" focus for the plan.

2. Prepare a plan that is success oriented, achievable, defendable, and cost–effective but which can handle the changes that will come.

3. Have a contingency plan for each identified risk.

4. Develop a plan that reflects organizational commitment to systems engineering.

5. Look for and abolish fraction–of–a–job situations.

6. Perform each task according to the plan.

7. Change the plan as soon as experience shows a better way to do a task.

8. Remember: micro–management is not planning.

9. Remember Dwight D. Eisenhower's words: "Plans are nothing. Planning is everything."

Tongue in Cheek

From the Internet:

Subject: If architects had to work like programmers

Dear Mr. Architect:

Please design and build me a house. I am not quite sure of what I need, so you should use your discretion.

My house should have between two and forty–five bedrooms. Just make sure the plans are such that the bedrooms can be easily added or deleted. When you bring the blueprints to me, I will make the final decision of what I want. Also, bring me the cost breakdown for each configuration so that I can arbitrarily pick one.

Keep in mind that the house I ultimately choose must cost less than the one I am currently living in. Make sure, however, that you correct all the deficiencies that exist in my current house (the floor of my kitchen vibrates when I walk across it, and the walls don't have nearly enough insulation in them).

As you design, also keep in mind that I want to keep yearly maintenance costs as low as possible. This should mean the incorporation of extra–cost features like aluminum, vinyl, or composite siding. (If you choose not to specify aluminum, be prepared to explain your decision in detail.) Please take care that modern design practices and the latest materials are used in construction of the house, as I want it to be a showplace for the most up–to–date ideas and methods. Be alerted, however, that kitchen should be designed to accommodate, among other things, my 1952 Gibson refrigerator.

To insure that you are building the correct house for our entire family, make certain that you contact each of our children, and also our in–laws. My mother–in–law will have very strong feelings about how the house should be designed, since she visits us at least once a year. Make sure that you weigh all of these options carefully and come to the right decision. I, however, retain the right to overrule any choices that you make.

Please don't bother me with small details right now. Your job is to develop the overall plans for the house: get the big picture. At this time, for example, it is not appropriate to be choosing the color of the carpet. However, keep in mind that my wife likes blue.

Also, do not worry at this time about acquiring the resources to build the house itself. Your first priority is to develop detailed plans and specifications. Once I approve these plans, however, I would expect the house to be under roof within 48 hours.

While you are designing this house specifically for me, keep in mind that sooner or later I will have to sell it to someone else. It therefore should have appeal to a wide variety of potential buyers. Please make sure before you finalize the plans that there is a consensus of the population in my area that they like the features this house has.

I advise you to run up and look at my neighbor's house he constructed last year. We like it a great deal. It has many features that we would also like in our new home, particularly the 75−foot swimming pool. With careful engineering, I believe that you can design this into our new house without impacting the final cost.

Please prepare a complete set of blueprints. It is not necessary at this time to do the real design, since they will be used only for construction bids. Be advised, however, that you will be held accountable for any increase of construction costs as a result of later design changes.

You must be thrilled to be working on as an interesting project as this! To be able to use the latest techniques and materials and to be given such freedom in your designs is something that can't happen very often. Contact me as soon as possible with your complete ideas and plans.

PS: My wife has just told me that she disagrees with many of the instructions I've given you in this letter. As architect, it is your responsibility to resolve these differences. I have tried in the past and have been unable to accomplish this. If you can't handle this responsibility, I will have to find another architect.

PPS: Perhaps what I need is not a house at all, but a travel trailer. Please advise me as soon as possible if this is the case.

An SE Fable

Why System Engineering?

Extracted from the book by Roger A. Kaufman

(C) 1966, by Douglas Aircraft Co., Inc.

Once upon a time, there were two pigs (a third one had gone into marketing and disappeared) who were faced with the problem of protecting themselves from a wolf.

One pig was an old−timer in this wolf−fending business, and he saw the problem right away −− just build a house strong enough to resist the huffing and puffing he had experienced before. So, the first pig built his wolf−resistant house right away out of genuine, reliable lath and plaster.

The second pig was green at this wolf business, but he was thoughtful. He decided that he would analyze the wolf problem a bit. He sat down and drew up a matrix (which, of course, is pig Latin for a big blank sheet of paper) and listed the problem, analyzed the problem into components, and possibilities of wolf strategies, listed the design objectives of his wolf−proof house, determined the functions that his fortress should perform, designed and built his house, and waited to see how well it worked. (He had to be an empiricist, for he had never been huffed and puffed at before.)

All this time, the old−timer pig was laughing at the planner pig and vehemently declined to enter into this kind of folly. He had built wolf−proof houses before, and he had lived and prospered, hadn't he? He said to the planner pig, "If you know what you are doing, you don't have to go through all of that jazz." And with this, he went fishing, or rooting, or whatever it is that pigs do in their idle hours.

The second pig worked his system anyway, and designed for predicted contingencies.

One day, the mean wolf passed by the two houses (they both looked the same −− after all, a house is just a house). He thought that a pig dinner was just what he wanted. He walked up to the first pig's house and uttered a warning to the old−timer, which was roundly rejected, as usual. With this, the wolf, instead of huffing and puffing, pulled out a sledge hammer, knocked the door down, and ate the old−timer for dinner.

Still not satiated, the wolf walked to the planner pig's house and repeated his act. Suddenly, a trap door in front of the house opened and the wolf dropped neatly into a deep, dark pit, never to be heard from again.

Morals:

1) They are not making wolves like they used to.

2) It's hard to teach old pigs new tricks.

3) If you want to keep the wolf away from your door, you'd better plan ahead.

Sometimes, the System is in the Eye of the Beholder

From the Internet, Author unknown

Two young boys had the contents of a box of Tinkertoys lying on a table before them. The first boy picked up all the pieces and said, "Look, these pieces make a Ferris Wheel"

The second boy took apart the wheel and, using the same sticks and knobs reassembled them. "No," he said. "They're a Merry−Go−Round".

If you would like to contribute to the Newsletter with a

- *Personal Commentary*
- *Feature Article*
- *Book Review*
- *Cartoon*

or any other article, contact the editor listed on the front cover of this newsletter. Your comments and suggestions on any Systems Engineering topic are most welcome!

Your 1997 Midwest Gateway Chapter of INCOSE Board of Directors

President:
M. John Schrader
(314) 232–6430
mschrader@mdc.com

Vice President:
Robert Scheurer
(314) 234–1608
rscheurer@mdc.com

Secretary:
Don Hess
(314) 233–7834
dhess@mdc.com

Treasurer:
Ralph Lambert
(314) 234–9462
rlambert@mdc.com

Director:
Carol Wilke
(314) 233–8451
cwilke@mdc.com

Director:
J. Owen Carson
(314) 234–2048
ocarson@mdc.com

Director:
Dr. Ken Sivier
(217) 333–3364
ksivier@ux1.cso.uiuc.edu

Director:
Paul Summers
(314) 232–4784
psummers@mdc.com

Past President:
Ken Kepchar
(314) 234–8156
kkepchar@mdc.com

If Your Address Has Changed, Please Notify:

Ralph Lambert, Midwest Gateway INCOSE, Treasurer
McDonnell Douglas Aerospace
Mail Code S034−1265
P.O. Box 516
St. Louis, MO 63166−0516

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