# SOLEtech

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In This Issue:



## Functional Analysis: Developing A "Functional" Description Of The System

***Ben S. Blanchard, CPL, Fellow, Professor-Emeritus, Virginia Tech***

### Preamble

The past three issues of the ***SOLEtech*** have concentrated on the *system engineering process* and the development of logistics and related requirements within this process. The basic steps which define the process are presented in Figure 1, and the specific area of emphasis in this newsletter is reflected by Block 3. It should be noted at this point that the steps shown are iterative in nature, with continuous feedback, and that what is represented in Block 3 constitutes a culmination in attempting to describe the system in *functional* terms. Actually, the *functional analysis* commences with the development of the *needs analysis* (i.e., the identification of the "functions" that the system needs to accomplish -- see Block 1) and continues through the development of *system requirements* (Block 2). It is the objective herein to provide a summary description of the functional analysis and the establishment of a *functional baseline* which will serve as a foundation for all subsequent system design activities.

### Functional Analysis Objectives

An essential element of early conceptual and preliminary design is the development of a *functional* description of the system to serve as a verification of architectural approach and as a basis for the identification of the resources (e.g., hardware, software, people, etc.) that will be necessary for the system to accomplish its objective(s). A "function" refers to a specific or discrete action (or series of actions) that is necessary to achieve a given objective; that is, an operation that the system must perform to accomplish its mission, a maintenance action that is necessary to restore the system to operational use, a transportation activity that is essential for the distribution of system components, and so on. Such actions may ultimately be accomplished through the use of equipment, software, people, facilities, data/information, or combinations thereof. However, at this point, the objective is to specify the **"WHATs"** and not the **"HOWs";** that is, *what* needs to be accomplished versus *how* it is to be done! It is soooooo easy to try to define the "HOWs" before identifying the "WHATs." Experience has indicated (in many instances) that items are often purchased based on what was initially perceived as being a "requirement" but that later turns out to be not needed in the end which, in turn, can be quite costly. In applying the principles of systems engineering, not one piece of equipment, module of software, data item, or element of support should be identified and purchased without first having justified the need for such through the functional analysis. The functional analysis is an iterative process of breaking requirements down from the system level, to the subsystem, and as far down the hierarchical structure as necessary to gain the required visibility and to identify input design criteria and/or constraints for the various elements of the system. The accomplishment of such can be facilitated through the use of functional flow block diagrams, as illustrated in Figure 2. Commencing in the early stages of conceptual design, the functions that must be accomplished in the initial development and production of the system and then in its "operational" use (i.e., those required for mission completion) are identified. These ***operational*** functions are then expanded and formalized through the development of system operational requirements (refer to the January 2002 ***SOLEtech***). Primary ***maintenance and support*** functions for the system, which evolve from the operational requirements, are identified as part of the maintenance concept development process. Subsequently, these functions must be expanded to include **all** of the activity from the initial identification of need to the retirement of the system. Such functional identification can be limited to a high level of definition, or broken down to the depth necessary for the purposes of design definition. The results of this activity constitute an **input** to the design process.

### System Operational Functions

*Operational functions*, in this instance, constitute those that describe the activities that must be accomplished in order to fulfill the mission requirements (i.e., the *forward* flow of activities illustrated in Figure 4 in the article, "Logistics In The Context Of The System Life Cycle," published in the

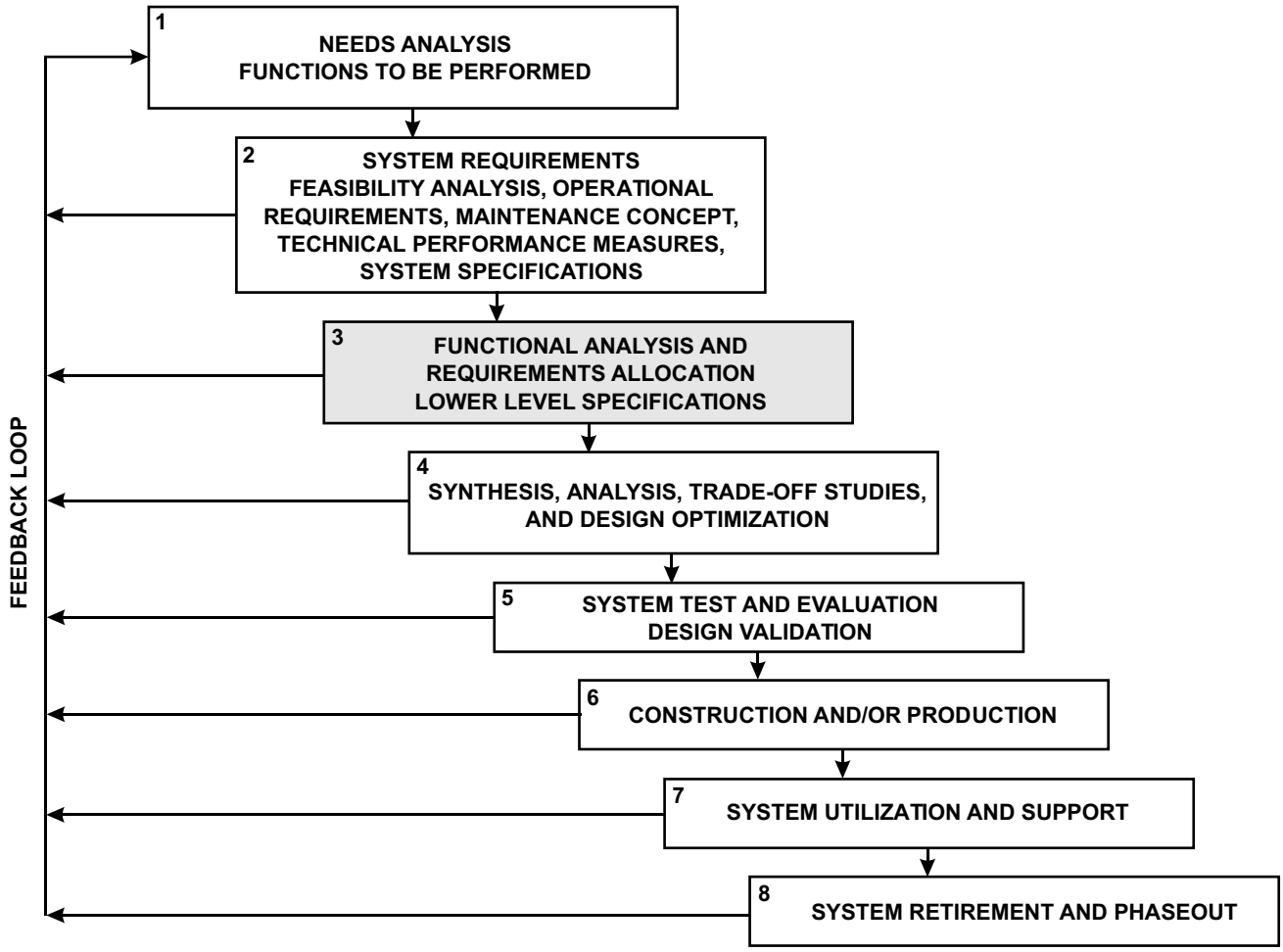



**Figure 1. Steps in the system life cycle (with emphasis on system design)**

November 2001 ***SOLEtech***). These may include both (1) those activities that involve the design, development, production/manufacture, and distribution of the system for operational use; and (2) those activities that are related directly to the completion of a given system scenario by the consumer/user. In the second category, these may include a description of the various modes of operation and utilization. For instance, typical high-level operating functions may entail (1) *prepare aircraft for flight;* (2) *transport material from the factory to the warehouse;* (3) *initiate communications between the producer and user;* (4) *produce "x" quantity of units in a seven-day timeframe;* and (5) *process "a" data to eight distribution outlets, in "b" time, with "c" accuracy, and in "d" format.* System functions necessary to successfully complete the identified modes of operation are then described.

Figure 3 illustrates a simplified operational flow diagram, with an example of a maintenance functional flow diagram evolving from Function 4.2. The objective is to commence at the left with the identified need and to flow to the right leading to design, manufacture, operation, and to the retirement of the system. The next step is to break these functions down to the depth necessary (as illustrated in Figure 2), establish some "GO-NO/GO" criteria for each functional block, and to progress to the right with "GO" decisions and downward with "NO-GO" decisions (leading to the definition of a maintenance functional flow). Note that the words in each block are "action-oriented" and the block numbering allows for the top-down/bottom-up *traceability* of resource requirements. [1]

## Maintenance Functions

Once the operational functions are described, the system development process leads to the identification of *maintenance and support* functions (i.e., the *reverse* flow of activities illustrated in Figure 4 in the article, "Logistics In The Context Of The System Life Cycle," published in the November 2001 ***SOLEtech***). For example, there are specific performance expectations or measures associated with each block in an operational functional-flow diagram. A check of the applicable functional requirement will indicate either a "GO" or a "NO-GO" decision. A "go" leads to a check of the next operational function. A "no-go" indication

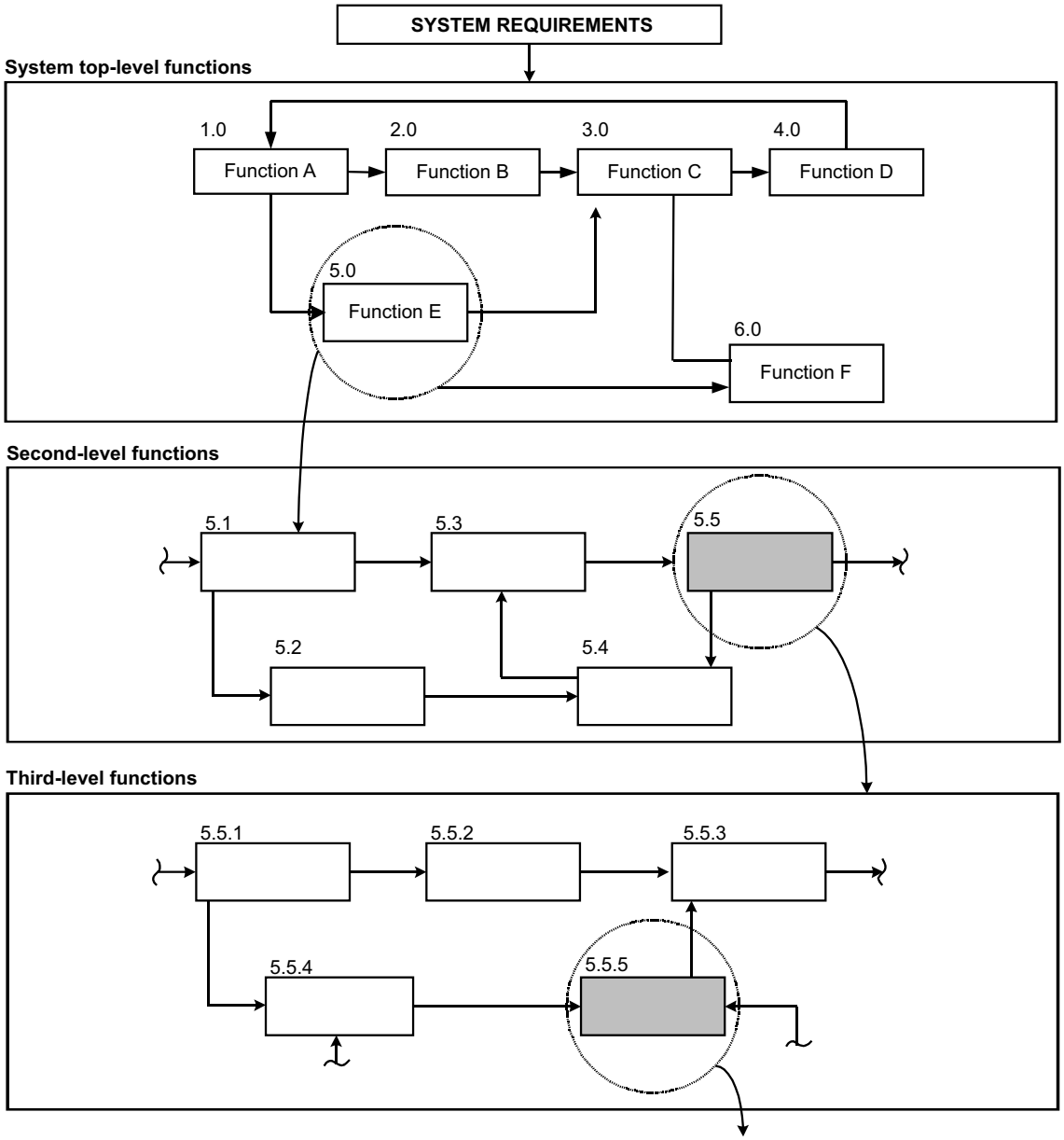



**Figure 2. System functional indenture levels (functional breakdown)**

(constituting a symptom of failure) provides a starting point for the development of a detailed maintenance functional flow diagram. As the preliminary design phase evolves, each of the functional activities identified in the operational functional flow diagram should be "tested," resulting in the development of a maintenance loop such as illustrated in Figure 3 (note that at the end of the maintenance loop there is a feedback connection to the operational flow).

## Functional Integration And Resource Identification

As conveyed earlier, the functional analysis and the development of the functional flow diagrams describe the "WHATs" that must be accomplished to achieve the desired objectives. Conversion to the "HOWs" is accomplished by evaluating each individual block, defining the necessary *inputs* and *outputs*, describing external controls and constraints, and determining the mechanisms by which the function could be accomplished. Specific quantitative effectiveness factors (e.g., the metrics evolving from the QFD process described in the February 2002 ***SOLEtech***) may be established for each block. In response to a given functional requirement, there may be a number of different feasible design options, and trade-offs are accomplished leading to a recommendation of a preferred approach. By defining the *mechanisms* or the *resources* required for accomplishing a given function, one is led to identification of the appropriate hardware, software, people, facilities, data/information, and/or combinations thereof. Figure 4 shows an example illustrating this process. Having completed this process on an initial basis for all elements of the system, the next step is that of combining and integrating these various resources into an effective and efficient maintenance and support infrastructure entity.

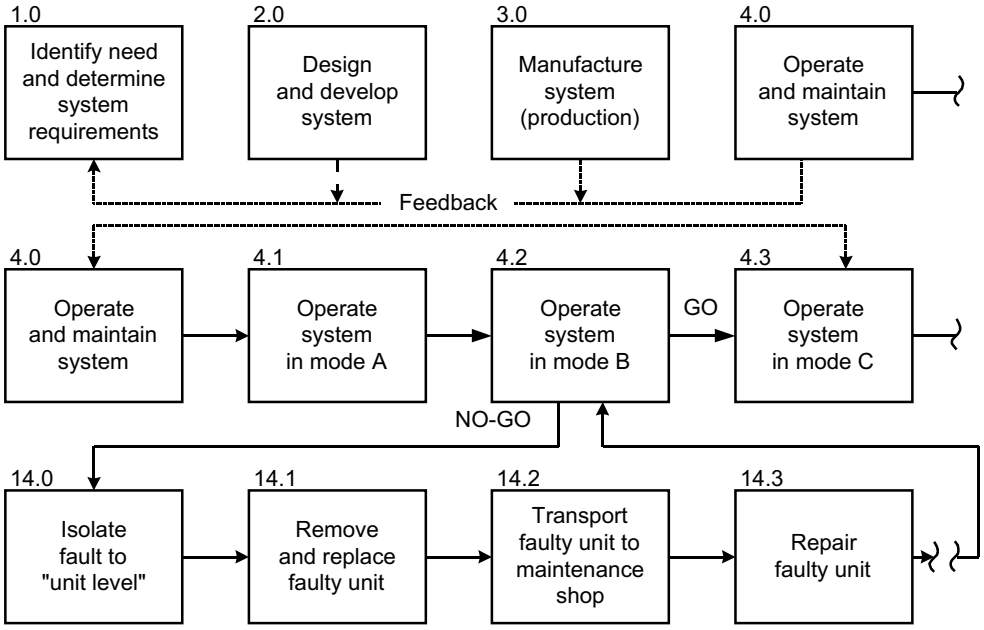



**Figure 3. Functional block diagram expansion (partial)**

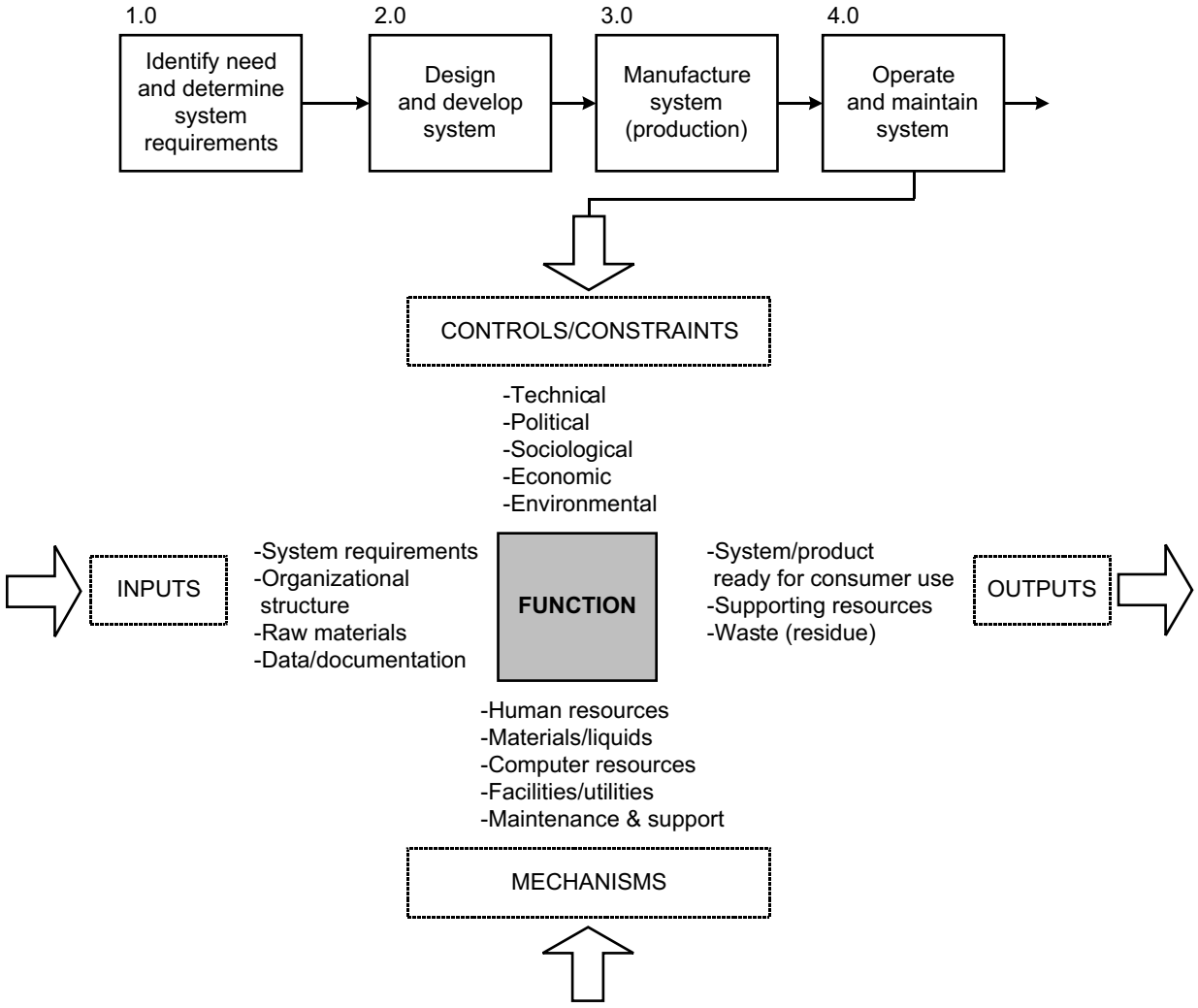



**Figure 4. Identification of resource requirements (mechanisms)**

## Applications And Benefits Derived From Functional Analysis

Basically, the *functional analysis* constitutes an iterative process leading to the early description of a system in "functional" terms, in progressing from the "WHATs" to the "HOWs," and to the subsequent definition of the system configuration (i.e., packaging of elements) and the resources (i.e., hardware, software, people, facilities, data/information, etc.) required in the development and production of a system that will ultimately fulfill the desired objective(s). The goal is to establish a *functional baseline* which, in turn, leads to the development of specific design requirements. This functional baseline is then converted, resulting in the packaging and identification of the various physical elements that make up the system (i.e., subsystems, units, assemblies, hardware, software, etc.). From this, the *requirements* (i.e., TPMs) at the system-level are then *allocated* (or *apportioned*) downward to these system elements providing an input to design. The partitioning and allocation process will be described further in the April ***SOLEtech***.

The *functional analysis* constitutes a critical step in the early system design and development effort, and it forms a *common* and *integrated* "baseline" for many design activities that are conducted subsequently. For example, it serves as a basis in the development of (but not limited to) the following:

1. Reliability and maintainability models (block diagrams) utilized in early allocations, predictions, and analyses;
2. Failure mode, effects, and criticality analysis (FMECA) and fault-tree analysis (FTA);
3. Reliability-centered maintenance (RCM) analysis;
4. Level-of-repair analysis (LORA);
5. System safety/hazard analysis;
6. Operator task analysis (OTA) and operational sequence diagrams (OSDs);
7. Maintenance task analysis (MTA);
8. Supportability analysis (SA);
9. Producibility and disposability analyses;
10. Life-cycle cost analysis (LCCA).

Relative to benefits, the functional analysis helps to ensure that:

1. ALL facets of system design and development, production, operation, support, and retirement are considered (i.e., a disciplined approach covering all activities within the system life cycle);
2. ALL elements of the system are fully recognized and defined (i.e., prime equipment, software, facilities/utilities, people, data/information, and the elements of support);
3. A means is provided for relating system packaging concepts and support requirements to specific functions (i.e., satisfying the requirements of good functional design);
4. The proper sequences of activity and design relationships are established along with critical design interfaces (i.e., a precise definition of functional interfaces to facilitate the design and integration of major system components and, in particular, the incorporation of COTS items).

It is should be emphasized that ALL activities and resources should be developed from the "ONE" (and SAME) functional baseline. On programs where a functional analysis is not completed early (or at all), one often finds that different assumptions (and from different baselines) are made in completing each of the various subsequent design analysis activities such as noted above. This, of course, results in possible omissions, inconsistencies, and increased costs in the long term.

## Summary

The objective herein was to introduce the *functional analysis*, and to stress its importance as a major element inherent within the systems engineering process. It provides a "basis" for all subsequent lower-level design requirements and is the foundation from which all logistics and maintenance support requirements are determined. While the principles and concepts associated with the development of a functional analysis are fairly well accepted universally, the specific format and nomenclature may vary somewhat, from one application to the next, depending on one's background and experience. At this point, it would be highly worthwhile to review some of the systems engineering literature, identified in Section "B" of the "Logistics Bibliography" located on the SOLE web site, in order to acquire a more complete understanding of the subject area and its applications. [2]

## Notes:

**[1]** Blanchard, B.S. & W.J. Fabrycky, *Systems Engineering And Analysis*, 3rd Ed., Prentice Hall, NJ, 1998. Appendix "A" includes a description covering one method that has been used in the development of functional flow block diagrams. Examples of operational and maintenance functional flow block diagrams are included. Also, refer to Chapter 3, Section 3.6, in Blanchard, B.S., *Logistics Engineering And Management*, 5th Ed., Prentice Hall, NJ, 1998.

**[2]** Refer to the SOLE web site --- **http://www.sole.org/**. Click on "Member Services" and then "Logistics Bibliography." Section "B" includes a number of references for *Systems*, *Systems Engineering*, *And Systems Analysis*. The various references with "Systems Engineering" in the title include some discussion on *functional analysis.*

## *Elsewhere . . .*

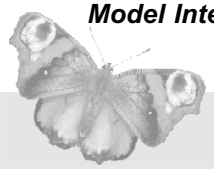
### CrossTalk - The Journal Of Defense Software Engineering.

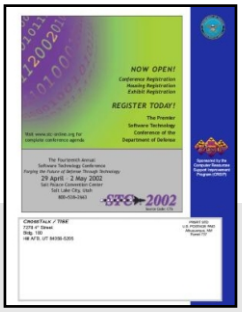

The theme of the February 2002 issue (Vol. 15, No. 2), published by the Software Technology Center (STSC), Ogden Logistics Center, Hill AFB, UT 84056-5205 (**www.stsc.hill.af.mil**) is "CMMI - Capability Maturity Model Integration." Included in this issue are the following articles which may be of interest: *Updated CMMI Focuses On Broader Usage In Industry And Government* by H. Bruce Allgood; *CMMI Version 1.1: What Has Changed?* by Mike Phillips; *CMMI Appraisal Methodologies: Choosing What Is Right For You* by Ilene Minnich; *To CMMI Or Not To CMMI: Issues To Think About* by Winifred Menezes; *Transitioning From SA-CMM To CMMI In The Special Operations Forces Systems Program Office* by Bonnie Bollinger; *How Do I Make My Organization Comply With Yet Another New Model?* by Sarah A. Sheard; *How Function Points Support The Capability Maturity Model Integration* by Carol Dekkers and Barbara Emmons; and *U.S. Army Develops High Quality, Extremely Low Cost Digital Message Parser* by Edgar Dalrymple.

Since the late 1980s, Capability Maturity Models (CMM) have been developed for a variety of disciplines to include software engineering, systems engineering, software acquisition, work-force practices, and integrated product and process development. Of particular interest is the Systems Engineering Capability Maturity Model (SE-CMM) which was developed in 1995. This and related "models" have been used on a number of occasions to evaluate current organizations in terms of effectivness and efficiency. As the number of different models has been increasing (and since this results in added costs), there has been a recent effort leading to the "integration" of these various tools. This issue of ***CrossTalk*** is the second dedicated to the Capability Maturity Model Integration (CMMI) project. If you are not familiar with what has been going on in this area, it would be worthwhile to commence with a review of July 2000 issue of ***CrossTalk*** first and then review this issue. Back issues can be found online at the Software Technology Support Center (STSC) web site **www.stsc.hill.af.mil**. At this point, you may wish to review CMMI Version 1.1 which was released in January 2002. This could serve as the "platform" for the addition of a tool that could, in the future, be used for the evaluation of a logistics organization.

The theme of the March issue (Vol. 15, No. 3) is "Software By Numbers." Included in this issue are the following articles which may be of interest: *Getting The Numbers Out In The Open* by Elizabeth Starrett; *Let The Numbers Do The Talking* by Donald J. Reifer; *How CMM Impacts Quality, Productivity, Rework, And The Bottom Line* by Michael Diaz and Jeff King; *Statistical Process Control Of Project Performance* by Walt Lipke; *Are You Prepared For CMMI?* by Suzanne Garcia; *Correctness By Construction: Better Can Also Be Cheaper* by Peter Amey; and *Modeling And Simulation CMMI: A Conceptual View* by Frank Richey. Several of these articles are a natural follow-on to the articles on "CMMI" in the February issue and are definitely worth reviewing.

***"CMMI Capability Maturity Model Integration."***






**February 2002 Issue**

*Elsewhere . . . (continued)*

## The International Symposium On Product Quality And Integrity

***Marvin Pinard, SOLE West Coast Representative On The RAMS Board Of Directors***

***RAMS-2002*** was a continuation of a long series of annual symposia (in its 48th year of operation), held at the Westin Seattle Hotel, Seattle, WA, January 28-31. The symposium theme was "Beyond 2001 - The Reliability And Maintainability Odyssey Continues," and there were over 400 attendees. The program included 22 tutorials, 2 workshops, 21 paper sessions, 5 panels, and a large number of exhibitors (to include a display of various assurance tools, textbooks, and services).

A special feature this year was a ***Logistics And Supportability Panel*** which addressed logistics and supportability issues as well as the relevance and effects of R&M considerations on logistics and in the design of products. Dr. Ralph L. Harper (SOLE/LEF) was the moderator and the panelists were C.M. (Chuck) Huber (Huber Consultants International and SOLE's BOA), Thomas J. Edwards (Deputy to the Commander, U.S. Army Combined Arms Support Command), BG John M. Urias (Deputy Commanding General for Acquisition, U.S. Army Space and Missile Defense Command), Thomas J. Ridgway (Chief, Technical and Quality Policy Division, Logistics Operations, Defense Logistics Agency), and Jerry Hudson (General Manager, CTC, and Chairman of NDIA's Quality Subcommittee).

RAMS continues to be strongly supported through SOLE participation with Dr. Ralph Harper, Dr. Caroline Smith, and Larry Wolfe on the Management Committee; Jacques Durand on the Publicity Committee; Dr. Joel Nachlas on the Publications Committee; Rich Sackett on the BOD Long Range Planning Committee; Dr. Dinesh Verma (201-216-8645) as the East Coast Representative; and Marv Pinard (tel: 408-730-1590) as the West Coast Representative. ***RAMS-2003*** is scheduled to be held at the Tampa Waterside Marriott Hotel, Tampa, FL, January 27-30, 2003.

## 9th Annual Technical Conference (Florida LOG 2002)

The 9th Florida LOG, sponsored by the six Florida SOLE Chapters, and held at the Orlando Delta Resort Hotel, Orlando, FL, February 15-16, represented another in a series of successful regional conferences. The Plenary Session "Keynoter" was Todd Mellon (Naval Air Systems Command) who spoke on "Balancing The Logistics Equation Through The Focus Use Of Performance-Based Logistics Instruments"; and the Banquet Speaker was Neil D. Shuster (President and CEO of the Intelligent Transportation Society of America) who spoke on "A National Integrated Data Network For Transportation Security." Dr. Russell Vacante (TRANSLOG International and SOLE BOA) chaired a panel session which addressed "Safety And Security Issues Pertaining To Intermodal Transportation Systems And Related Infrastructure." The panelists included Dr. J. Helmick (Captain, U.S. Maritime Service) and Dr. Bahar Barami (Senior Economist, Volpe Center, U.S. Department of Transportation). Dr. Elizabeth Rivers (NOVA) conducted a day-long tutorial on "Lean Thinking, Lean Manufacturing, and Six Sigma." Charles Coogan (President, ALE) conducted a tutorial on "Performance-Based Supportability." Additionally, there were numerous other presentations on a wide variety of subjects, along with a number of exhibits. The General Chair for the conference was Raymond T. Hoopes (Past President of SOLE), and he and his committee are to be complimented for an excellent event.

[Editorial note: I felt that there was a large emphasis by many of the speakers on the subject of safety and national security, particularly with the 9-11 experience in mind, and that the U.S. still remains highly vulnerable to possible future terrorist activities. It was interesting to learn (from Captain Helmick) that there are over 11 million cargo containers per year shipped in and out over 360 domestic ports in the U.S.; and there are 7 million cruise liner passengers and 25 major cruise lines operating from 16 ports and departing for foreign destinations. The question is -- how does one address the national security issues pertaining to the logistics of passenger and ship cargo handling? All in all, I found some of discussion(s) to be very interesting and relevant in view of today's challenges, BSB].

*Elsewhere . . . (continued)*

## 4th Annual Professional Development Workshop And Technical Conference -- Mid-Atlantic LOG, Hampton, VA, April 11-14 -- PLAN TO REGISTER NOW!

The SOLE Chapters in District 2 are once again sponsoring and hosting Mid-Atlantic LOG, to be conducted at the Holiday Inn, 1815 West Mercury Blvd., Hampton, VA, April 11-13. The theme is "Logistics: Beyond 2002." There will be a workshop and CPL training session included, along with many technical paper presentations. The Keynote Speaker for Friday (April 12th) will be Jay Mabe, Senior Partner, Accenture; and for Saturday (April 13th) the Keynoter will be MG Hawthorne Proctor, Director, Logistics Operations, Defense Logistics Agency. April is a great time to visit the Virginia Tidewater area; so, please register early. For additional information, contact John Davids (tel: 410-993-8172; e-mail: **john_h_davids@mail.northgrum.com**) and/or SOLE Headquarters (**solehq@erols.com**).

## *Calendar of Events*

1. *4th Annual Mid-Atlantic Professional Development Workshop And Technical Conference (Mid-Atlantic LOG 2002)*, sponsored by the SOLE Chapters in District 2, Holiday Inn, 1815 West Mercury Blvd., Hampton, VA, April 11-14. Refer to the information described earlier in this newsletter and to the SOLE web site (**www.sole.org**).

2. *Supply-Chain World-North America Conference And Exposition*, sponsored by the Supply-Chain Council (SCC), Hyatt Regency Hotel, New Orleans, LA, April 22-24. The theme is "Extending Collaboration To End-To-End Synchronization: Managing The Supply Chain Network For Competitive Advantage." For additional information, contact the Supply Chain Council, 303 Freeport Road, Pittsburgh, PA 15215 (tel: 412-781-4101; fax: 412-781-2871; e-mail: **info@supply-chain.org**).

3. *11th Annual TACOM/Industry Logistics Symposium*, sponsored by the U.S. Army Tank Automotive And Armaments Command and NDIA, Northfield Hilton Hotel, Troy, MI, April 16-18. The theme is "Innovative Logistics - Achieving The Army Transformation." For additional information, contact Cherice Carter, TACOM Co-Chair (810-574-4175) or Ignacio Cardenas, NDIA Co-Chair (810-574-8150).

4. *25th Annual Warehousing Education And Research Council (WERC) Conference*, Hyatt Regency Hotel, Chicago, ILL, April 28-May 1. For further information, contact WERC, 1100 Jorie Blvd., Suite 170, Oak Brook, IL, 60523-4413 (tel: 630-990-0001; fax: 630-990-0256; e-mail: **werc@werc.org**).

5. *14th Annual Software Technology Conference*, Salt Palace Convention Center, Salt Lake City, UT, April 28-May 2. The theme is "Forging The Future Of Defense Through Technology." Scheduled for the opening sessions are Congressman James V. Hansen (R), 1st District of Utah, and Lloyd K. Mosemann, Senior Vice President for Corporate Development, SAIC. There are eight tracks with a wide variety of technical paper presentations, eight tutorial sessions, and numerous panels. For additional information, visit web site **www.stc-online.org** and/or call 800-538-2663.

6. *Institute Of Industrial Engineers (IIE) Annual Conference 2002*, sponsored by IIE, Hilton Hotel, Walt Disney Resort, Orlando, FL, May 19-20. For additional information, contact **cs@iienet.org** and/or visit web site **www.iienet.org**.

7. *2nd Annual Supply-Chain World-South East Asia Conference And Exposition*, sponsored by the Supply Chain Council (SCC), Grand Hyatt Hotel, Singapore, May 21-22. The theme is "Collaborate, Trust, SCOR: Keys To Supply Chain Success." For additional information, contact the Supply Chain Council, 303 Freeport Rd., Pittsburgh, PA 15215 (e-mail: **info@supply-chain.org**).

8. *International Conference Of Maintenance Societies (ICOMS-2002)*, organized by the Maintenance Engineering Society of Australia (MESA), Hilton Hotel, Brisbane, Queensland, Australia, May 21-24. The theme is "Changing The Future." The Conference will include a variety of workshops and exhibits, in addition to the many technical paper presentations. Papers presented in Brisbane will be broadcast simultaneously to a conference venue at the Central Queensland University's campus in Gladstone. For further information, contact Sally Nugent, P.O. box 634, Brentford Square, Victoria 3131, Australia (icoms@corrprev.org.au) and/or visit web site **www.mesa.org.au.**

9. *EUROMAINTENANCE 2002*: 16th International Maintenance Congress, Helsinki, Finland, June 3-5. For additional information, contact Hannu Vallanen (tel: +358-9276-7688; fax: +358-9290-0081). Also, visit **http://www.kunnossapito.fi/Congress/call-pap.htm.**

## Calendar of Events (Continued)

10. *8th IEEE International Symposium On Software Metrics (Metrics 2002)*, Ottawa, Canada, June 4-7. Visit web site **www.software-metrics.org.**

11. *2002 Digital Human Modeling For Design And Engineering Conference, Munich, Germany*, June 18-20. For additional information, contact John R. Miller (jrmiller@sae.org) and/or visit web site **http://www.sae.org/calendar/gvmtgs.htm.**

12. *12th Annual International Symposium On Systems Engineering, sponsored by the International Council On Systems Engineering (INCOSE)*, Riverina Hotel, Las Vegas, NV, July 28-August 1. The theme is "Engineering 21st Century Systems: Problem Solving Through Structured Thinking." For additional information, contact INCOSE Headquarters at **incose@halcyon.com** and/or visit web site **www.incose.org.**

13. *2002 International Military & Aerospace/Avionics COTS Conference, Exhibition, And Seminar,* Mission Valley Marriott, San Diego, CA, August 7-9. For further information, contact Edward B. Hakim (tel: 732-449-4729; fax: 775-855-0847; e-mail: **ebhakim@bellatlantic.net.**

14. *37th Annual International Logistics Conference And Exposition (SOLE 2002),* sponsored by SOLE, Pointe South Mountain Resort, 777 South Mountain Parkway, Phoenix, AZ 85044, August 10-15. The theme is "21st Century Logistics: The Global Bridge." For additional information, contact John Davis, General Chair (**JDavisCPL@aol.com**) or SOLE Headquarters (**solehq@erols.com**).

15. *15th International Congress And Exhibitions On Condition Monitoring And Diagnostic Engineering Management (COMADEM)*, University of Birmingham, United Kingdom, September 2-4. For additional information, contact Professor B.K.N. Rao (**rajbknrao@btinternet.com**) and/or visit web site **http://www.comadem.com.**

16. *Council Of Logistics Management's Annual Conference*, Moscone Center, San Francisco, CA, September 29-October 2. The theme is "The Rules Are Changing ....." The Keynote Speaker for the opening session will be Michael L. Eskew, Chairman and CEO, United Parcel Service. For further information, contact CLM Headquarters at clmadmin@clm1.org and/or visit web site **http://www.clmadmin@clm1.org/conf2001/confinfo.asp.**

17. *18th International Logistics Congress And Exhibition (ILC-2002)*, Gasteig Arts Center, Munich, Germany, October 6-9. The Conference theme is "Outsourcing Life-Cycle Support: Sharing The Risks, Sharing The Opportunities." A formal "Call for Papers" has been initiated, with March 28th as the "target" date for the submission of abstracts -- refer to the article on the Congress included in the February 2002 ***SOLEtech***. For additional information, visit web site **www.sole-muc.de** and/or the SOLE web site at **www.sole.org.**

18. *28th International Symposium For Testing And Failure Analysis (ISTFA-2002)*, Phoenix, AZ, November 3-7. For further information, contact Donald D. Dylis at **DDylis@IITRI.org** or contact **ISTFA@asminternational.org.**

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