The Certified Systems Engineer – It's About Time! [1]

Joseph Kasser
Systems Engineering and Evaluation Centre
University of South Australia,
Mawson Lakes Campus, Room F-37
Mawson Lakes, SA, 5095
Australia
Email: Joseph.Kasser@unisa.edu.au

Abstract

Recognizing that a process is only as good as the people who perform it, this paper defines the requirement for the certification of systems engineers to establish a minimum level of competency for systems engineers. After a brief survey of how other disciplines certify their practitioners, this paper discusses the derived requirements for implementing the certification process and recommends an approach to prototype and administers the certification process for systems engineers.

Background

Recognizing that major government funded systems development has traditionally been characterized by cost and schedule overruns and other (spectacular) failures, attempts have been made to alleviate the situation.

Major systems development takes place over a period of years in a scenario wherein periodic payments are made by the customer to the supplier based on the supplier's promise that all is well and the product is being manufactured on schedule and within budget. It is only after months or years of making these progress payments that the customer finds out that problems exist and large amounts of money may have been wasted.

In an attempt to minimize the risk of cost and schedule overruns, the customer has tried a number of different approaches to improving the product and the process.

- **The product** - Quality Assurance, Test and Evaluation, and Independent Verification and Validation, try to ensure that the product not only works, but is also the right product. Testing the intermediate products as they are being built does this. (Deming 1982, p 11) was very much in favor of building quality into the product in the first place. He wrote, *"Defects are not free. Somebody makes them, and gets paid for making them"*.
- **The process** - As (Deming 1982, p29) wrote "*Quality comes not from inspection, but from improvement of the production process*". The customer has attempted to improve the supplier's processes by emphasizing "standards" and "best practices". The basic assumptions being that well-established processes compliant to standards minimizes waste, and hence saves money. The most widely known examples of these standards are the International Organization of Standards (ISO) 9000 series and the system and software engineering Capability Maturity Models (CMM).

However, a major cause of cost and schedule overruns has so far not been addressed, namely the people involved in the systems engineering process (Kasser and Williams 1998) even though the situation has been recognized for a long time. For example, twenty years ago, (Frosch 1969), the then Assistant Secretary to the United States Navy, wrote, *"Systems, even very large systems, are not developed by the tools of Sys-*

[1] This work was funded from the DSTO SEEC Centre of Expertise Contract.

tems Engineering, but only by the engineers using the tools."

(Deming 1982 p366) also wrote, *"People are part of the system"*

This paper addresses the issue of improving the quality of systems engineering by improving its practitioners. It does this by applying models gleaned from other disciplines. Systems engineering techniques were used in this study as described herein.

The problem of poor systems development was stated at the beginning of this paper. The next milestone was the realization that the people dimension was being ignored, yet in other disciplines there exist ways of guaranteeing the quality of the personnel. Consider these examples.

- **Management** - The Institute of Certified Professional Managers (ICPM) provides certification for professional mangers.
- **Software Engineering** – The American Society for Quality (ASQ) provides various certifications for the quality disciplines. The state of Texas also recently certified software engineers.
- **Engineers** – The Institution of Electrical Engineers (IEE) in the United Kingdom offers the Chartered Engineer (CEng) designation for professionalism in engineers.

It is time for systems engineers to be certified in a similar manner to attempt to guarantee that the personnel involved in the systems engineering process are possessed of a degree of competency. The customers can then feel that the more certified systems engineers working on their major system development, the greater the probability that their funds will be expended in a more effective manner.

After much research in the non-systems engineering literature, it was found that according to (Lawler1973) -

Ability = f (Aptitude * (Training + Experience))

Where:

- **Ability** refers to how well a person can perform at the present time. If a person lacks the ability to accomplish a task, no amount of motivation or effort will lead to better performance (Kast and Rosenzweig, 1979).
- **Aptitude** refers to whether an individual can be brought through training and experience to a specified level of ability.

The purpose of certifying people as systems engineers is to ensure they are possessed of a minimum level of training expertise and experience. The employer can then address the issue of ability by providing the appropriate motivation. However, the certifying agency *cannot really certify the competence* of the person. The agency can however certify that *the applicant has shown proof of compliance with the requirements for certification.*

The Certified Systems Engineer

Given the requirement for a Certified Systems Engineer, the problem then becomes to define the model used to meet the requirement for certifying systems engineers.

After further research analyzing the similar situation in other disciplines which certify practitioners, the model proposed for certifying systems engineers is based on the Certified Manager (CM) designation by the ICPM in the field of management.

Having decided on the model, the problem then decomposes into the following derived problems.

1. What are the educational requirements?
2. What are the experience requirements?
3. How does the applicant for certification demonstrate compliance with the educational and experience requirements?
4. Who will administer the certification program?

Consider each of them in turn.

Educational Requirements. The education requirements must be set to for the applicant to demonstrate an understanding of what systems engineers do, as well as how and why they do it. Being able to do it by the book is not enough. The Systems Engineering Body of Knowledge (SEBOK) (Faulconbridge, and Ryan, 1999) could be a start in meeting these requirements.

Experience Requirements. Years of experience is not enough, the applicant must show continual growth and success, perhaps by publications and presentations at INCOSE symposia, conferences and chapter meetings. There must also be requirements for leadership experience and demonstration of successful project completion (Kasser, 1994).

Achieving compliance to the requirements for certification. Two models can be adapted. One approach requires that the applicant sit a comprehensive examination written by the administering organization. However, writing suitable questions is not a trivial task. They need to be multiple choice to simplify grading the responses, but there is a skill in writing good questions. The question has to be phrased in such a manner that the answer is obvious to someone who understands the subject while at the same time two or more of the solutions seems correct to someone who does not know the subject[2].

Another approach would be based on achieving a master's degree in a discipline covering the SEBOK.

Administration. This is the hardest issue because the administering body has to have a degree of credibility in the discipline. INCOSE is an organization in which anyone interested in the topic can pay the fee and join. This is the same as the IEEE. Membership does not provide an indication that the member has achieved a threshold of knowledge. On the other hand, the IEE has particular education requirements for degrees of membership

These organizations are not suitable as developers and administrators for several reasons that include:

- They are not suited for developing and prototyping a certification process in a short period of time.
- They don't have the understanding of the SEBOK.

The System Engineering Society of Australia (SESA) with its links to INCOSE and IEEAust. seems to be a neutral body with the qualifications and expertise to develop and administer the prototype certification process. Its location in Australia, these days is no impediment. While it takes time to move people and packages by air, electronic communications are essentially as fast between Australia and the rest of the world as they are between any two points within a hundred miles of each other in the United States or in the European Union.

The recommendation is that SESA be the administering body in its prototyping phase.

Recertification. To ensure that systems engineers remain current with emerging techniques, periodic recertification as employed by the ICPM is required.

Levels of Certification

Recognizing that systems engineers are grown there should be master and apprentice levels of certification. The ICPM uses a two level approach for certifying managers. In systems engineering the recommendation is for two levels:

- **Certified Systems Engineer** – someone who has demonstrated compliance with both the educational and experience requirements.
- **Associate Certified Systems Engineer** - someone who has demonstrated compliance with either the educational or the experience requirements.

[2] Based on a seminar given by the Educational Testing Service and experience in the workshop that wrote the questions for the initial Certified Quality Manager examination for the American Society for Quality.

The Prototyping Approach

It could take years to set up the perfect certification program. Getting all the stakeholders to agree on the requirements and if specific applications meet them is a major problem. The proposed solution to the setting up problem is to attempt to avoid it by using the "Rapid Prototyping" approach to set up a baseline, start doing the job, then measure the results and modify the process using change control techniques. The proposed sequence is:

1. Develop a baseline version of the SE-BOK.
2. Develop the experience requirements.
3. Publish the requirements for certification.
4. Begin certifying systems engineers based on academic qualifications by the year 2002.
5. Evaluate the program after 12 months.
6. Upgrade the certification requirements every 24 months.
7. Develop an examination over the next 12 months.

Conclusions

There is a need for certification of systems engineers. Obtaining consensus on the requirements for certification is not a trivial problem and will take time and lots of discussions. A prototyping approach was suggested as a way to minimize or avoid the consensus problem. SESA is an ideal organization to prototype the certification process. It is time to go for it.

References

Frosh, Robert A. *"A new look at systems engineering"*, IEEE Spectrum, September 1969, p 25.

Deming W. Edwards, *Out of the Crisis*, MIT Center for Advanced Engineering Study, 1982, 1986.

Faulconbridge, Ian, and Ryan, Mike, "A Framework for Systems Engineering Education", *Systems Engineering Test and Evaluation (SETE) Conference*, Adelaide, Australia, 1999.

Kasser, Joseph E., *Applying Total Quality Management to Systems Engineering*, Artech House, 1995.

Kasser, Joseph E., Williams, Victoria R., "What Do You Mean You Can't Tell Me If My Project Is in Trouble?", *First European Conference on Software Metrics (FESMA 98)*, Antwerp, Belgium, 1998

Kast, Fremont E., and Rosenzweig, James E., *Organization and Management A Systems and Contingency Approach*, McGraw-Hill Book Company, Third Edition, 1979, p 246.

Lawler, Edward E. III, *Motivation in Work Organizations*, Brooks/Cole Publishing Company, 1973, pp. 8 - 9.

Author

Dr. Kasser is both a DSTO Associate Research Professor at the University of South Australia (UniSA) and a Distance Education Fellow in the University System of Maryland. He performs research into improving the acquisition process and teaches systems and software engineering subjects. Prior to taking up his position at UniSA, he was a Director of Information and Technical Studies at the Graduate School of Management and Technology (GSMT) at University of Maryland University College (UMUC). There, he was responsible for the Master of Software Engineering (MSWE) degree and the Software Development Management track of the Master of Science in Computer Systems Management (CSMN) degree. He is a recipient of NASA's Manned Space Flight Awareness Award for quality and technical excellence (Silver Snoopy), for performing and directing systems engineering. Dr. Kasser also teaches software engineering via distance education.