

# Doing Things Right in Space Programs

This article is part of a series started in January, 2000. My intent is to share a philosophy and ideas for how to increase the chances of success in space missions while also reducing total cost. Once these articles are completed, I plan to assemble them into a book. Please send comments to me at Tom.Sarafin@instarengineering.com.

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## Article #11

### Concurrent Engineering: Transforming Buzz Words into Good Business

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(Written circa 1993)

**Note:** For this month's article, I asked my good friend, Pete (Poti) Doukas, if I could use an undated essay he had written on Concurrent Engineering. He sent me a copy several years ago; I thought it had a lot to offer then and still do today. I've included it here as a follow-on to last month's discussion of the 4<sup>th</sup> principle for Doing Things Right: Constantly seek ways to improve teamwork. Next month's article will continue following the ten principles with a discussion of the 5<sup>th</sup> one.—Tom Sarafin

Articles and speeches that laud the benefits of Concurrent Engineering (CE) have flooded the technical trade journals and seminar circuit. One statement pertaining to the implementation of CE seems to be common to all of the literature and talks: "There's no magic formula...you have to find what works best for your group's personality."

I have become increasingly frustrated with this "fend for yourself" attitude, but specific resources are scarce. Books that address synergism in the work place, such as the one by Buchholz and Roth<sup>1</sup>, are good motivators but fall short of providing what engineers can expect in terms of solutions. Besides, I believe there is more to CE than synergism. Many engineers can recall their most inspiring relationships and team efficiency on past programs occurring well before Total Quality Management (TQM) and CE became "buzz words."

In the past, technical details were understood only by those members of the design

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<sup>1</sup> Buchholz, Steve and Thomas Roth, *Creating the High-Performance Team*, John Wiley and Sons, Inc., New York, 1987.

teams who could mentally visualize the proposed concepts. The remaining project personnel had to wait for layout engineering to "see" those details. Today's computer-aided engineering, design, and manufacturing (CAE/CAD/CAM) systems enable everyone to see concepts in solid, 3-D color as they are being generated by the designers. With these tools, more people can become contributing team members much sooner than in the past. Compared to the teamwork achieved on past programs, this is synergism *times* synergism, or *synergism-squared*.

The top management of many corporations have proclaimed their vision to adopt TQM, of which CE is a part. But its actual implementation seems to get bogged down in the middle management ranks. In the defense of program managers, it is truly difficult to (1) relinquish the control they've traditionally held to implement a common sense plan for CE or (2) make the up front investment of time and money to train and organize the CE team. The engineers, themselves, are often heard to say, "Don't bother me with more meetings and organizing ...I've got work to do." But I must take issue with those who say there is no formula for implementing CE or leading a CE team.

The initial organizing must rely less on cheer leading and, instead, stress tools and methods to make employees more effective. Group training, consisting of technical education mixed with team building exercises and examples that are directly applicable to the design team's needs and experiences, can give engineers material they can immediately apply to the job. The instructors should remain with the team for consultation during follow-on exercises. While the added instructor expense does increase training costs, the example exercise can consist of contractual project work. The actual work progress with instructors, who are experts in their fields, adds a valuable contribution to that effort for the short time they are involved.

The CE formula begins with actions taken by management:

1. Provide technical training—By infusing your team with state-of-the-art techniques, not only do employees become more efficient at their work, but they also receive the message that management is willing to invest in *them*.

The team's motivation rises along with individual self-worth. Training replaces any need for motivational speakers or incentives.

The team will develop its common personality earlier if they are trained together, and the associated interdisciplinary education improves each individual. A. Thomas Young (*editor's note: former executive at Lockheed Martin*) was quoted as saying, "When the times are tougher is when training budgets should be increased, not decreased. That's a counter-intuitive thing, but it's the way it should be."<sup>2</sup> As a point of reference, at the time of this writing, Motorola, the Baldrige award-winning corporation, allocates two percent of their annual payroll to training their employees.

2. Introduce team-building exercises—Have experts teach the group new methods and tools available for running effective meetings, for coming to group decisions, for prioritizing tasks. It is during this phase that a collection of individuals develops a personality and evolves into a team.
3. Set the stage—Bring everyone together to focus their attention on the challenges ahead. Explain your vision for meeting those challenges. Reflect on the training just received and how it applies to overcoming the obstacles that

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<sup>2</sup> A. Thomas Young, Interview in *Manufacturing Systems Magazine*, March, 1991 issue.

lie ahead.

4. Assign the task—Set clear, concise goals and milestones. Define the criteria for success. Set limits. Identify any sacred cows and the rationale for them.
5. Define team roles and responsibilities—Follow up with each individual to outline job descriptions, accountability, and authority. Work together to develop performance objectives.

Here's where the team takes over...

6. List subtasks—Mutually identify the input and output to be transferred between disciplines so that tasks can be completed. Agree on the content and format for passing this information.
7. Generate individual schedules—Have each team member construct a personal engineering work plan (EWP), taking into account the project-imposed milestones, but factoring in commitments to other teams that may have to be supported simultaneously. List the date you plan to receive or submit every input and output identified in the previous step.
8. Obtain consensus—Combine the individual work plans to see how well the planned transfer of input/output information matches. The team training investment is put to use justifying, negotiating, and compromising your plan against what the other team members have in mind. If the team agrees that imposed milestones just cannot be met, this process generates the team's basis of estimate that may be brought to management for disposition.

A team member's first experience with this process tends to "turn on the light bulb." I didn't have the faintest idea what "culture change" and "owning the schedule" meant before producing my first team-generated EWP.

Management will notice curiosities about employees about this time. They number of inside jokes floating around the work place will increase. Notices will be posted on the walls, reminding team members to sign up for after-hours group activities. The program manager might also inherit a new nickname. All of these are positive signs of cohesion in the work force.

The CE process continues...

9. Agree on team operations—How often should team meetings be held? How will you be assured that all the right contributors are invited to splinter sessions? Who will chair the meetings? Who will take notes? Who will attend from management; the customer?"
10. Develop metrics—I have many reservations concerning the direction of metrics within the company. What does help are those metrics that focus on the CE process. One I particularly like is to monitor the number of TBDs in the requirements document ... provided you don't intentionally omit entire sections just to avoid the unknowns. Some goal setting is also required. There's little use boasting over a 50% reduction in the number of B-Spec TBDs as compared to the last reporting period if the actual number remaining is twenty—and you're conducting a Preliminary Design Review!  
  
Individuals will benefit from recording their own metrics. Data will be put to good use estimating future tasks.
11. Finally, conduct health and status checks—Make the time to periodically reflect

on lessons learned. Designate someone, not part of the group, to be a team mentor. Ask individuals to observe your operations from time to time and solicit their feedback. If management retains any autocratic tendency, it should pertain to continually urging team members to talk to each other about how things are going.

There will, naturally, be special situations where forming EWP schedules won't fit the task. A modified process might look like this:

**Management:**

- State vision
- Assign the task
- Set limits
- Define roles and responsibilities

**Team:**

- Meet to set ground rules, identify needs, etc.
- Discuss issues as a group or split up to start problem-solving process
- Reconvene to compare results and come to consensus
- Report in
- Discuss your performance

The issues to discuss might include requirements flowdown, trade-study options, weight-savings ideas, or whatever a design team might do.

On the topic of requirements, a good point was recently voiced by an electrical engineer on the SUPER program at Lockheed Martin Astronautics. He stated that his CE team made their most dramatic progress when they challenged those requirements initially believed by the group to be untouchable. His team collectively grins with anticipation whenever they hear, "You can't do that!"

I haven't given up totally on the CE articles and speeches. Someday, someone will address some of the CE issues that program managers can put to direct use. Can new team members undergo training and successfully be accepted without having the comradery of the initial experience? Can the team personality evolve into a clique and become counterproductive? Can the team become entrenched with their method and close themselves to further improvement?

Keep reading the articles and attending the seminars to find these answers...but let's not forget to keep talking to each other.

**About the Author**

Pete Doukas is a Senior Staff Engineer at Lockheed Martin Astronautics, in Denver, Colorado. He has been with Lockheed Martin (formerly Martin Marietta) for over 23 years as a stress analyst and supervisor. Early in his career, he worked on the external tank for the Space Shuttle, at Michoud Space Systems, Louisiana. At Denver, he has worked on a variety of NASA and military spacecraft. Pete was a contributing author to *Space Mission Analysis and Design* [James R. Wertz and Wiley J. Larson, editors, first edition published in 1991 by Microcosm and Kluwer] and *Spacecraft Structures and Mechanisms: From Concept to Launch* [Thomas P. Sarafin, editor, 1995, Microcosm and Kluwer].

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