Manufacturing Affordability

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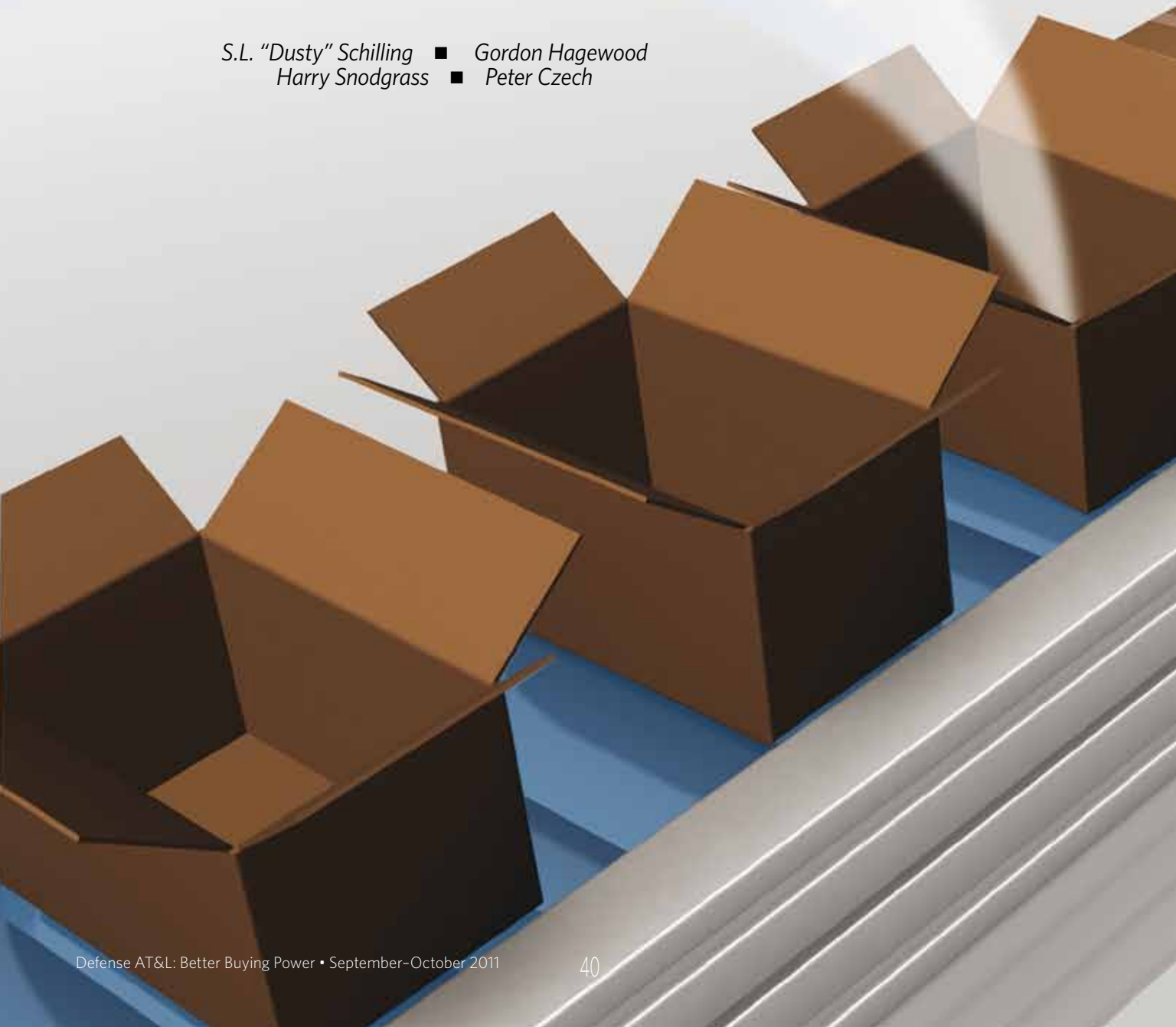

Recent statutory and policy changes have stressed the need for program affordability and identified areas where it might be best achieved. This renewed focus is based on anticipated challenges to future DoD budgets—as we decrease our operational tempo and as we face the largest deficits and national debt in our history. Within the traditional trade space of affordable cost, technical perfor-

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mance, and timely delivery, affordability has been elevated to at least a quasi if not de facto key performance parameter.

Every major program has significant touch labor opportunities to leverage and part of the producibility plan needs to be a formal system for review and application of lessons learned.

Manufacturing affordability is a significant factor in achieving overall program affordability. That said, affordability in manufacturing is not a task that can be mandated. Directing that preliminary design reviews be accomplished prior to Milestone B falls into the "mandated" category. It follows a simple "if/then/else" logic of disciplined completion criteria. In contrast, affordability in manufacturing is an outcome of how programs are managed.

Effective planning early in and throughout program development is critical to enabling manufacturing affordability. There is no silver bullet and no magic to ensuring manufacturing affordability. To succeed, we must get back to the basics.

Our research identifies at least four essential elements of controlling manufacturing costs:

1) Broad-based engineering design trades that consider production line planning and producibility early in program life cycle

Achieving affordability for DoD weapon systems and products requires a focused effort on producibility during the initial phase of weapon system design.

So what is this producibility focus?

Producibility requires a coordinated effort by the systems/design engineering team and the manufacturing/industrial engineering team. Functional hardware designs that can be consistently replicated with the desired quality, lead time, and cost objectives are the goal, and, if well executed, the result. As trades are considered for capability, schedule, and design costs, their impact on manufacturing as part of an overall producibility program must be considered: Will my suggested change in performance drive the need for critical technologies in my production line that do not currently exist? Can a schedule change subsequently impact my schedule for prototyping my initial production line? If I lean out cost from my preliminary design effort, will that be at the expense of my overall producibility plan or product quality?

Design should optimize the ease and economy of fabrication, assembly, inspection, test and acceptance—the latter two representing some measure of quality. Quality is the ability to produce this product without non-conformances or issues that cause the part to fail inspection. Good design can dramatically reduce the need for inspection. Good design also considers reliability and maintainability of the product. These considerations complement the engineering and manufacturing planning that includes the selection of materials, tooling, facilities, capital equipment, test equipment, methods, processes, and personnel to make the product.

We learn through experience. And typically, some experience consists of unexpected lessons. "Gee, this stove is hot" may be an unexpected lesson for the toddler but should not be so for the adult. All production programs learn important producibility lessons during the actual manufacturing process. A more proactive approach would incorporate producibility best practices much earlier in the design process. If your focus as a program manager is only on how well you design the product to meet performance, and not how efficiently it can be manufactured, then do not be surprised when you are overcome by scrap, rework, and costly redesign!

So who is responsible for producibility? Every PM should be able to answer this question about his or her program. Perhaps you have heard the saying: "In the commercial world, nobody gets paid until something gets made." That said, defense industry design engineers get paid long before and after anything gets made. That does not mean they don't continue to participate in the manufacturing affordability process.

There is design engineering, and there is manufacturing engineering; rarely can one individual do it all. If you don't have significant participation from the manufacturing side of the business in program design efforts from day 1 of Engineering and Manufacturing Development, you should be seriously worried. A program that includes the following types of considerations can execute a producibility program with significant cost savings when compared with traditional, less structured approaches.

2) Controlling physical configurations

Once we start production, a key element to controlling manufacturing costs is reducing configuration changes. Controlling change limits unexpected alterations to material buys, to production line processes and contributes to constraining cost growth. Changing a line on a design drawing while early in the paper phase is low cost. Making that same change later may still be a great idea, but the implications will be costly. These changes may affect many things, including significant

documentation change costs; redesign of sub-systems and components, and even actual production line equipment such as tooling (jigs, dies, and fixtures), machine setup, work instructions, etc.

But wait! We want learning curve improvements included in our production runs, right? Learning curve improvements are generally linked to touch labor efficiencies gained through repetition. These gains really do demonstrate the meaning of "practice makes perfect if you practice perfectly." Every major program has significant touch labor opportunities to leverage and part of the producibility plan needs to be a formal system for review and application of lessons learned. Yes, we do want some change, if that change results in producibility improvements and net cost savings.

Consider that cell phone in your pocket. During its production run, an incremental design update would be a rare event. Further, production would not stop "just to tweak the system for a little more performance." Large production lots run to completion, and only then are significantly new variants introduced. Given the nature of DoD products, we may feel the need to introduce technical performance changes during production, but in terms of controlling manufacturing cost, you are far better off getting the product design frozen up front.

Remember, EMD stands for engineering and manufacturing development. Knowing what is "good enough" in the design engineering phase can help us develop the required producibility improvements during the manufacturing phase. If no other point is apparent by now, it should be that there are myriad variables to consider from initial design through full-rate production. Establishing the right balance takes a skillful PM with a disciplined internal stakeholder management and communication plan that makes all areas of potential trade clear and mutually understood. A disciplined battle rhythm that executes these plans needs to be established as part of the technology development phase and tailored as the program matures.

3) Stabilizing lot and total quantity buys

For decades, the defense community has recognized the negative impacts of production quantity instability. All of us know that uncertainty in annual lot sizes and reductions in the total quantity buy lead to per unit prices increases. But how many of us really understand how to talk about the specifics?

Economic order quantity (EOQ), economical production rate (EPR) and minimum sustaining rate (MSR) are familiar terms that sound obvious but are surprisingly difficult to pin down and use effectively in communication. The first challenge is that these terms are specific not only to a product, but also to a particular producer's specific situation. Calculations for one supplier may not be same as for another. How many production lines or facilities do we require? How many shifts will the vendor run? Is the order large enough to keep one facility operating all year? Will there be a break in production between annual buys? All these factors and more go into the determination of EOQ, EPR, and MSR.

Be aware that EPR and EOQ are not really the same thing. In DoD, we often use EOQ to refer to, well, what it sounds like it ought to mean—the most economical rate for buying end-item deliverables to the government. If you as a PM are talking about EOQ when discussing what budget levels to fund to and what size lot buys to make, you are probably using EOQ in the above sense.

However, in industry, EOQ (sometimes called the Wilson EOQ) is commonly used when determining inventory stock buys, because that EOQ calculation factors in things like costs of holding inventory and order placement costs. Within DoD, that specific use of the term EOQ calculation is associated with advanced procurement material, not with final end-item deliverables.

Regarding EPR: Please note that that technically, the EPR calculation is defined in the DoD Financial Management Regulations specifically referring to one shift, 8 hours per day for 5 days per week, which may in fact not be the most economical lot-size order.

The bottom line is that you, the PM, need to understand how to communicate effectively about quantity instability impacts, to recognize that you will be dependent on industry providing production rate and minimum sustaining rate estimates, and that your ability to assess their accuracy will be limited.

Stabilized production rates would significantly aid achievement of manufacturing affordability across DoD. We all know that the service budget allocations drive the production numbers, and yes, we know that programs report these EPR/MSR numbers yearly on their P-form budget submissions. In addition, we understand that executing above a specific economic rate may make some people see your program as a funding source target. However, a new aspect to the funding allocation decision process might be reviewing how efficiently our entire DoD portfolio is performing. Perhaps we should expect to see the acquisition community:

- Focus in Defense Acquisition Board reviews on production rate funding commitments.
- Issue Milestone B and C acquisition decision memorandum direction for programs to achieve specific production rates.
- Publish overall assessments of how many acquisition category 1D and 1C programs are executing above economic production rate.

If this does in fact become a hot topic for senior management, it may be worth the while of individual program managers to understand just how confident they are in the development of and articulation of their program's EPR and MSR numbers.

4) Fitting manufacturing needs into contractor's strategic business plan

Efficient and affordable production depends on the industrial base supporting the specific type of manufacturing you need. However, significant change is on the horizon for U.S. industry. We in government may read about the many news reports detailing the emergence of China and other countries as sources of both manufactured goods and raw materials, but for industry, correctly positioning themselves in the competitive marketplace is critical.

Although stability in product design and quantity aid greatly in controlling manufacturing costs, the most fundamental truth is that early and persistent planning during design is critical to enabling manufacturing affordability during production.

One challenge we government program managers face as we approach acquisition programs is how to fit our manufacturing needs into our contractor's strategic business plans. Why is that important to me?

Most companies have long-term strategies in their business plans that guide them to which types of manufacturing programs they will embrace. Companies perform detailed analysis of the capital investment that is designed to decrease manufacturing unit costs. Companies conduct a thorough scrutiny of opportunities through the lens of cash flow, risk, profitability, labor requirements, and fit with corporate strategy. Experience, supported by data, demonstrates that manufacturing risk increases as the business moves from adding a few more units to the production process to starting an entirely new production line.

As a government PM, you might not be required to investigate this information. But as the contractor, when risk increases, so does the price. As a government PM, you need to investigate how our designs will affect the potential reuse of existing facilities, and the cost implications of the impacts associated with the risks that result from your decisions.

So what should a government PM be looking for in the industrial sector? Which companies look like a good fit strategically?

- How similar is your new program with the products the supplier is currently manufacturing?
- What are the current margins for the products being manufactured?
- What strategic manufacturing process will the supplier be able to capitalize on for future business? (e.g., a new robotic welding process)
- What advantages do you see for the supply base?
- What is the current state of manufacturing for your sector? What advantages or disadvantages does this situation bring to your project?

Knowing the suppliers' long-term strategy will help in making your program's manufacturing planning more viable.

Summary

Manufacturers with proven producibility programs have experienced 30 percent reductions in product development cost and time. These savings come from reductions of 50 percent in design changes, and most importantly 70 percent reductions in engineering changes after a parts initial release for production. These result in reductions in design labor costs and production rework.

Reductions of 30-50 percent in design labor costs, as represented by decreases in design labor time, are achievable. Likewise, producibility programs can reduce rework by as much as 80 percent. Given projections of the DoD budget, these are the kind of numbers we need to make our next generation weapon systems affordable.

Affordability in manufacturing is not one specific quantifiable task but, rather, an outcome of good program management. There is no silver bullet and no magic to production affordability. Although stability in product design and quantity aid greatly in controlling manufacturing costs, the fundamental truth is that early and persistent planning during design is critical to enabling manufacturing affordability during production. Internal stakeholder and communications plans, executed with a predictable battle rhythm, can help ensure success. Integral to these plans is the cross-functional visibility and common understanding of the factors that compete for attention from initial design to full-rate production. The authors agree that renewed emphasis on affordability in general, and manufacturing affordability in particular, are important initiatives for the Department—especially in view of anticipated fiscal challenges.

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