SEMICONDUCTOR R&D

The New Battlefield of Competitive Advantage

SMART COMPANIES PROFIT FROM INCREASED UTILIZATION AND PRODUCTIVITY

Numetrics

By David Breda & Ronald Collett

Today's semiconductor industry is undergoing enormous change that has profound impact on the operational strategies of semiconductor manufacturers:

- **Development cost:** The cost to develop a complex system-on-chip (SoC) ranges from $50-$100 million – making it crucial that devices hit the market on time. Even a slight schedule slip can reduce volumes needed to satisfy demand, leading to a disastrous loss of profit.
- **Manufacturing:** Many remaining vertically integrated device manufacturers (IDMs) have sold off costly fabs to improve their balance sheets. This shift away from fabs increases the importance of one of their remaining competitive differentiators: their R&D resources.
- **Investment:** Venture capital (VC) investment in semiconductor companies is at a 10-year low, according to the National Venture Capital Association. The ebb in funding reflects the changing ROI equation, a consequence of the enormous complexity and corresponding risk associated with integrated circuit (IC) development. Most VCs realize that only companies with world-class development capabilities and best-in-class productivity stand a chance of making a profit.
- **Cyclical nature of market:** During recessions, companies cut staff to keep R&D expenses in line with revenue. As the economy improves, thinned-out R&D organizations can be slow to respond to the new growth opportunities. As recovery occurs, growth from new-product development will be mostly limited to the productivity of their current engineering staff.

Differentiating by Doing More with Less

These forces are driving semiconductor companies to do more with less. So the senior management of these companies is putting their attention on R&D—and specifically on new-product development—where productivity is an important new source of competitive differentiation. As a result, R&D is fast becoming the semiconductor industry's new battleground.

The stakes are high in exploiting the industry transformation: engineering resources, product portfolios, schedules, capital and decision-making must be marshaled with new precision and management discipline. Why? R&D productivity is money. For a company trying to achieve a modest 7x revenue return on a $100 million complex IC project, every week delay for a two-year development costs the company approximately $1 million in engineering expenditures and $3 million in lost revenue over a four-year commercial life. Many chip makers will abandon such costly projects and attempt to seek safe haven in areas where development risk is far less. But such safety will be short-lived, because these havens will quickly crowd with competitors.

Path to Productivity

High productivity is a means to an end, and the way to get there is through maximum development throughput. Throughput is a measure of how much product the engineering organization churns out during a given period of time. In fact, without compromising quality, leading semiconductor R&D organizations boast exceptionally high throughput.

Chip firms embracing the urgency of boosting R&D throughput and achieving necessary levels of improvement are building best-in-class product-development organizations – and reaping the financial benefits. It is no coincidence they are also avoiding squandering R&D dollars on late-cancelled projects, reducing the number of schedule slips, boosting revenue growth, and achieving higher earnings.

Boosting Throughput

There are three ways to boost R&D throughput:

- Add headcount
- Increase work-hours per week
- Raise utilization and productivity

The first two have far-reaching, negative consequences: Raising R&D headcount increases cost, and more hours lead to workforce burnout and high turnover. Increasing engineering utilization and productivity are the only viable long-term strategies for sustaining high throughput.

Better Utilization: Gaining Resources at No Cost

Increasing R&D utilization—the percentage of the engineering workforce's effort spent on revenue-generating activities—is among the quickest and most effective ways to boost throughput. That's because it essentially increases R&D resources without incurring additional cost.

Organizations struggling with low utilization find their engineers spend more than half their time on non-revenue-generating activities, such as sales, customer support, and product support – all of which should be handled by different groups (*see figure 1*).[1] This means the engineering department spent less than half (44 percent) of its time (resources) on revenue-generating activities. In the case of a billion-dollar company spending 30 percent of sales on R&D, this can mean the company is investing $168 million a year on what appears in cost-accounting systems as engineering, but in fact these are activities that aren't creating new products to drive new revenue.

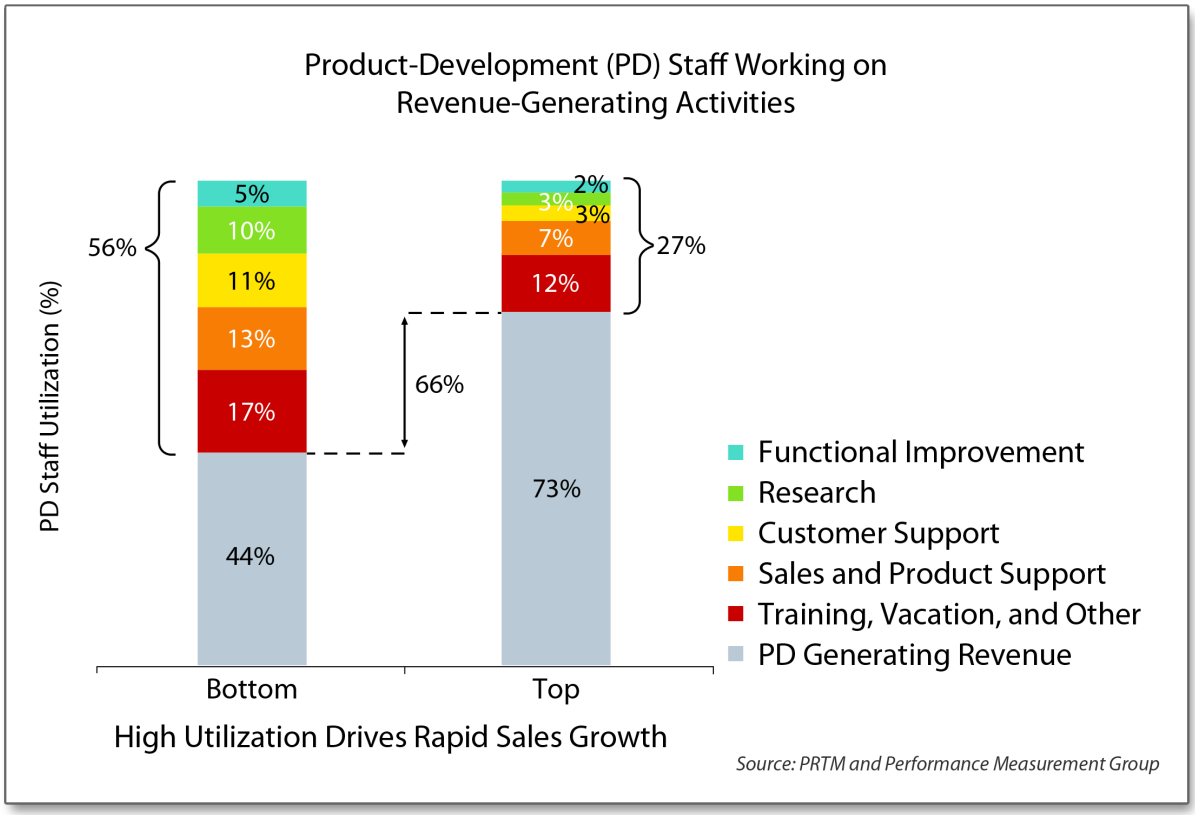

Figure 1

Best-in-class companies, however, have a sharply different utilization mix. Their engineering organizations spend 73 percent of their engineering time on activities that create persistent value and generate revenue.

[1] *Source:* PRTM & Performance Measurement Group

By shrinking the amount of time engineers spend on projects that get cancelled, non-core research, myriad internal initiatives, and so forth, companies can significantly raise their utilization rates and, in the process, reduce R&D spending and/or develop new revenue-generating products.

The difference in utilization rates between the bottom performers (44 percent) and the top performers (73 percent) means that the same billion-dollar company can expect to save $58 million a year in R&D expense, or increase revenues by more than $100 million by driving engineering throughput.

Higher Productivity: Creating New Designs with Less Effort

Productivity – the second factor driving throughput – is the amount of engineering output per unit of labor expended to create that output. Productivity is a function of efficiency. Only by improving efficiency will productivity rise (*see figure 2*). Analysis of R&D efficiency compares the effort a particular set of engineering tasks should consume to what they actually consume. Reducing the effort needed to complete a set of tasks raises efficiency, which increases productivity, and this gives rise to higher throughput.

How do you know if opportunities exist to improve engineering productivity? Below are some common symptoms of productivity "leakage" in an engineering organization:

- Lack of agreement on requirements before beginning design, driving costly rework late in development – excessive number of spec changes
- Inadequate project planning driving resource conflicts, schedule delays, feature reductions, or project cancellations late in development cycle
- Finding known bugs on reused IP in design after releasing the design to foundry
- Constantly reassign key resources from one project to another – driving churn
- Passing projects through gate reviews without committed plans (e.g., resources, schedules, budget)
- Excessive silicon spins prior to launch
- Multiple systems and formats (e.g., Power Point, excel, email) for project and product data driving "search" time for current plans/specs of record
- Lack of consistent use of product development metrics across organizations.

Fact-based Planning

Boosting productivity requires a reliable measurement system–one yielding accurate baselines and fair comparisons. Moreover, a robust measurement system paves the way for managers to determine the absolute minimum staffing projects need to finish on time. In this way, projects can be staffed to levels that assume the teams will meet an improved productivity level, which means the projects are "optimally understaffed." These fact-based plans reflect the bare minimum team sizes needed to finish projects within time-to-market constraints. They also ensure projects are staffed properly to meet the demands of hardware and software complexity (assuming the planned productivity improvements are realized).

Reliable, consistent measurement of engineering output is the lynchpin of fact-based planning, as well as measuring productivity and throughput. Measuring output demands an empirically-calibrated model that calculates and normalizes it.
An example of such a model is one using industry norm project effort as a proxy for engineering output. It must accurately estimate the total effort the average engineering team in the particular semiconductor industry application segment would expend to develop the particular design. Then compare that baseline, or industry norm, to the amount of effort actually spent by the development team. If the team expended less effort, then, by definition, it used resources more efficiently, and its productivity is therefore higher.

Readying for the New Era

A comprehensive approach to boosting utilization and productivity paves the surest path to improving throughput. How long does it take? Companies see significant gains in the first set of products exploiting improvement initiatives. Full organizational transformation typically requires two to three years to meet its potential – provided executive management is committed.

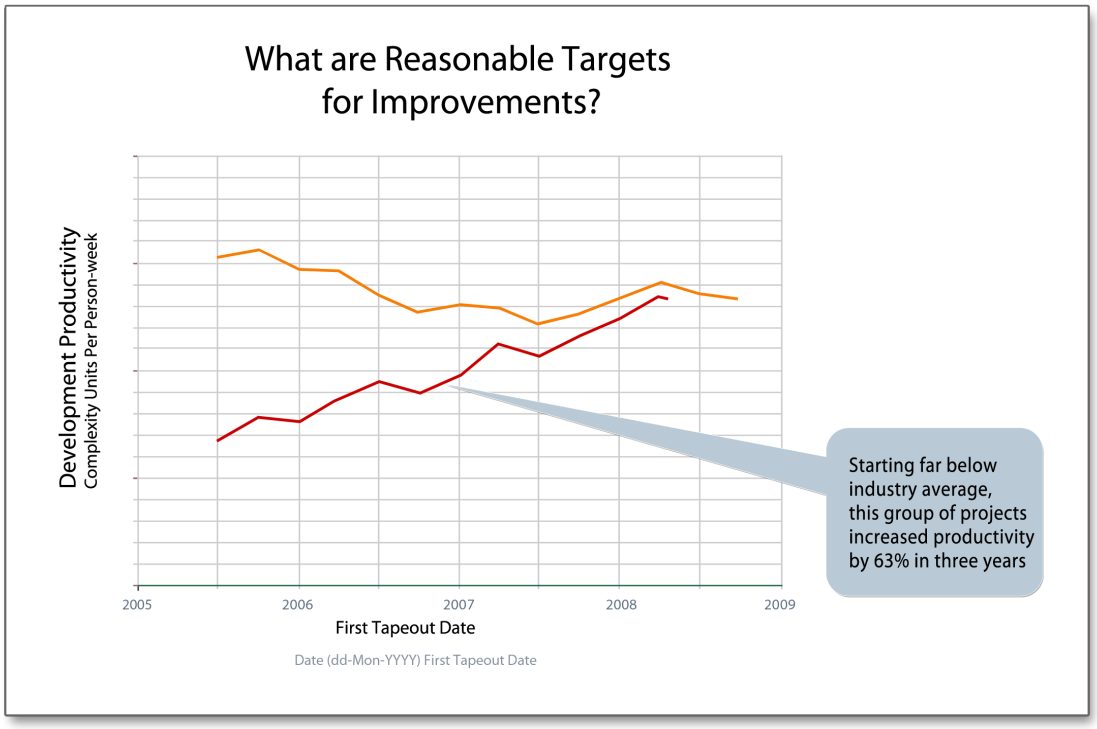

Figure 2

As figure 2 shows, the benefits can lead to significant improvement in product-development productivity, which boosts throughput and eliminates multimillion-dollar per-week losses due to delays. It also speeds new-product development, enabling rapid penetration into lucrative early-market windows.

Leading semiconductor companies are aggressively preparing for heightened R&D competition. They are transforming their R&D organizations to generate more financial value from product development. A focus on improving throughput through increased utilization and productivity provides a powerful advantage for semiconductor companies seeking a competitive edge.

Numetrics

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