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The Spectrum of Risk Management in a Technology Company

Managing Product Development Risk

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Managing Product Development Risk

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ABSTRACT

Product development at Intel has become increasingly complex as the company moves from delivering independent components to delivering usage-centric platform/ingredient systems. To better address the business issues that could prevent the success of the platform strategy, a product development risk process was developed and deployed. This process is based on the standard corporate risk management methodology and uses a database tool to provide consistent deployments across teams. The current process focuses on qualitative assessment of risks across product development. The deployment of this process has improved the quality of product development processes and reduced last-minute fire-fighting responses to issues. Active risk management. using common processes and tools has resulted in increased communication across large platform development teams, accelerated product launches, and quick responses to ecosystem changes. As teams gain experience in active risk management the focus will move towards more quantitative analysis. The future of product development risk management will tie schedule and risk management more closely together with Monte Carlo simulations to improve the predictability of launching a platform with the needed feature set in the time-to-market window.

INTRODUCTION

Intel is an innovative, cutting-edge semiconductor company, one of perhaps only a small handful of such companies. It has historically had significant market share for the worldwide semiconductor market, enjoying large margins.

Today, the business model is changing. Margins are shrinking under pressures from an increasingly competitive market, which requires new solutions to problems in new areas such as power consumption, form factor, and usage models. To successfully deliver in this market, Intel is changing its business model to deliver usage-centric platforms that require ingredients and ingredient groups to work with each other, and with external companies, to deliver complete integrated solutions–a new paradigm for Intel.

These challenges translate into a product development environment at Intel that is dynamic, intense, and stressful.

Risk management can help alleviate the negative qualities of this environment. Over the past two years, Intel's Corporate Program Management Office (CPMO), a group within the Corporate Platform Office (CPO), has dedicated a team to focus on development and deployment of standard Risk Management Processes and Tools across Intel that meet the needs of the product development environment. We, the members of the CPMO and CPO, have affected significant change in how Intel's product development teams approach risk.

Intel has a world-class risk management methodology. From this methodology we developed a process and a central risk database, High Speed Database-Risk (HSD-Risk), to provide a standard way to identify, assess, prioritize, and plan to prevent and deal with risks. This allows all members of the product development world to think of and talk about risk management in the same way. Before the risk management team began its work, there were many examples of different risk grading and impact systems, as well as different, non-compatible tools for capturing and communicating their risks, even within the same team. In the flexible multi-level team environment required by platforms, this simply wouldn't work.

While we achieved some successes in implementing risk management across Intel, we found that a common

process and database tool wasn't enough to ensure success. Team behavior had to change: instead of performing risk management as a "check the box" activity, teams had to learn to manage risk on a day-in day-out basis. The key to changing team behaviors lay in clearly defining the difference between "passive risk management" and "active risk management."

Actively managing risks has provided several teams with tangible results ranging from pulling in product launches to quickly reacting to the Microsoft Windows Vista* operating system changes. They have gone from proactively investing more capacity in verification systems to keeping the backend development timeline of a product in line with launch. As more teams across Intel adopt this common process and tools, success will become commonplace and have more impact.

Quantitative techniques using Monte Carlo schedule analysis are being piloted within the product development environment with excellent success. As Intel's active risk management capabilities continue to mature, quantitative techniques will play a greater role in decision making.

STANDARD RISK METHODOLOGY

Intel developed a Corporate Risk Management Methodology specification in 2001. The specification is broadly defined encouraging use by many different divisions and groups within the corporation. Adoption within product development was slow but steady with each team or group applying the specification in the way they thought best. With Intel's paradigm shift to a platform company in 2004 the need to develop and deploy a standard risk management process for product development became imperative. The many ingredients that make up a platform are spread across various business units, with each using their own risk management processes, terminology, and tools with different levels of sophistication. The first step was to standardize risk terminology, which was no easy feat, taking six months to complete. Once that was settled we moved on to adopt a standard process that proved to be much faster as we leveraged the professional standards provided by the Project Management Institute and the existing internal Corporate Risk Management Methodology specification. Our process is visualized in a simple 6-step cycle (Figure 1) and is explained as follows:

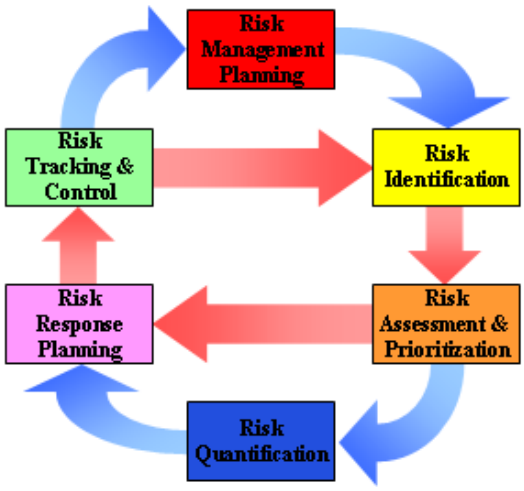

Figure 1: Risk management 6-step cycle

Step 1: Risk Management Planning

This is the process of deciding how to approach and conduct risk management activities. The key deliverable is the Risk Management Plan developed by leveraging a standard template.

Step 2: Risk Identification

This is the process of identifying, clearly describing, and documenting uncertainties that have the potential to impact project objectives.

When it comes to identifying risks many are found in the areas of the "Triple Constraint," i.e., schedule, cost (resources), and scope (requirements). Intel's competitive business terrain has market windows that reward first entrants to market. Intel sometimes meets those windows through whatever "brute force" means are required (e.g., extra headcount, 24/7 coverage, closely managing vendors). In these cases, schedule is fertile ground for risks (e.g., disconnects, assumptions) with the potential for high Return on Investment (ROI). At the same time, product development physical resources (head count) are expensive, and the right skill sets are hard to find and retain, and they are located all around the world. Scope is seemingly never reduced and new features are always being added to respond to an ever-changing marketplace.

In addition to these common risk categories are some "unique" risk categories. Technology risks are abundant; Intel develops cutting-edge products, as witnessed by its recent disclosure of 45nm technology. This leads to the need for new design tools, process flow tools, and equipment, all of which bring risks. Another unique category for risks is platform integration risk. Historically, Intel has sold microprocessors for desktop and laptop PCs. Now Intel has to learn how to create platforms that integrate CPUs, chipsets, boards, and software into

platforms that their customers want. Finally, Intel now has a more competitive climate. As a result, there is significant increased business risk from the subsequent margin compression pressures.

Drawing out these risks requires application of *identification techniques*. We considered many such techniques and have adopted several as good fits for Intel. The most commonly used techniques include structured brainstorming, expert interviews, and assumptions analysis.

When teaching teams about the importance of risk identification we discuss the concept of *known* versus *unknown* information (Figure 2).

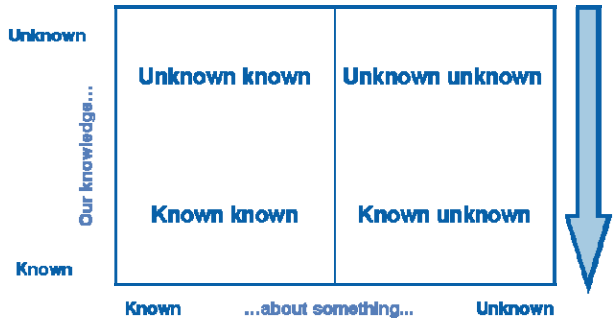

Figure 2: Known/unknown risks

The goal of the team is to drive as much information down into the Known portion (bottom half) as possible. Only the information in the bottom half is actionable. The majority of problems come from the Known-Known quadrant (lower left). Most risks are found in the Known-Unknown quadrant (lower right).

To drive more information down we encourage teams to "dial for data" i.e., call up people on previous projects and talk to them about what happened. Also, project managers are encouraged to study, in depth, post mortems from previous projects. These actions will drive information from the Unknown quadrants into the Known quadrants.

This is a critical concept for teams to understand. If we don't identify the risk we can't proactively manage it and our project objectives will suffer if and when the risk occurs.

Once a risk has been identified our standard requires that all risks be written in IF/THEN format with the "IF" stating what we are concerned about and the "THEN" stating why we are concerned. This phrasing helps make risks actionable.

Step 3: Risk Assessment and Prioritization

This is the process of determining the probability, impact, and urgency characteristics of individual risk items. The results are then used to establish risk response priorities across the collective set.

Without standard assessment criteria it would be impossible to prioritize across projects and divisions consistently. Cross-organizational risk prioritization is crucial to the success of our platforms. The two key assessments we make are regarding *severity* and *priority*. Like most risk processes, we assess severity using *probability* and *impact*. These two combined give us a risk code (Figure 3).

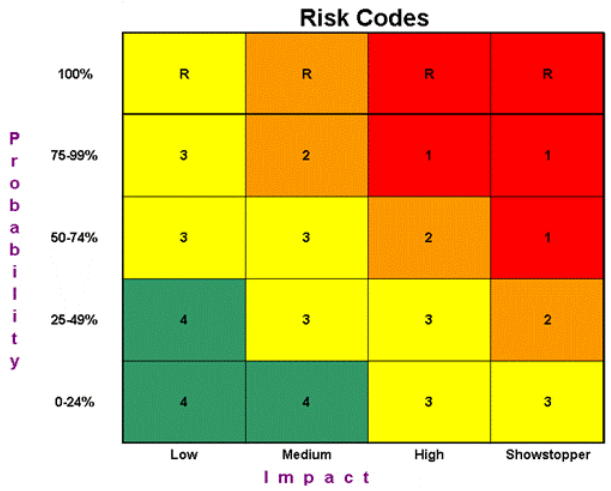

Figure 3: Risk code calculation

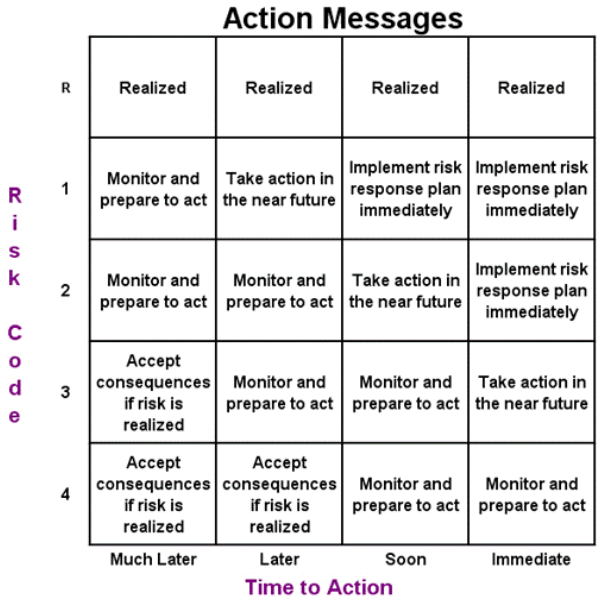

Figure 4: Action message calculation

Intel's product development risk process varies from most others with the addition of a third element to the assessment: *time*. We use Time-to-Action, which indicates how quickly the team must respond to the risk to reduce

its probability and/or impact. Once we have a risk code assigned for each risk we combine it with the Time-to-Action and calculate what we call the "Action Message" to assist in prioritization (Figure 4). The Action Message tells the team what action to take next based upon their assessment.

Step 4: Risk Quantification

This is the process of using statistical techniques to quantify risk impact. This is an optional step. These techniques are currently being piloted at Intel. More information is available in the "Future of Risk Management" section.

Step 5: Risk Response Planning

This is the process of developing and documenting Risk Response plans.

Table 1: Risk Response strategies

Proactive Risk Response strategies	
Avoidance	Transference
Prevention	Mitigation
Active Acceptance	
Reactive Risk Response strategies	
Contingency	Passive Acceptance

We use many response strategies, both proactive and reactive (Table 1). The most commonly used strategies are Prevention (which attacks probability), Mitigation (which attacks impact), and Contingency (which addresses the situation after the risk has occurred). We also differentiate between active and passive acceptance of risks, though some argument can be made that passive acceptance is a proactive response.

Response plans should clarify ownership, trigger dates and/or events, and the specific actions that will be taken to reduce the probability of the risk occurring and/or the resultant impact if it does occur.

The Action Message tells the team which risks require Risk Response plans. We generate many more risks than we can actually address, so setting priority and developing plans for the top risks are critical when it comes to using our limited resources wisely.

Step 6: Risk Tracking and Control

This is the process of periodically and continuously monitoring risks in order to ensure risk information is kept current and risk response plans are being executed, as required.

We encourage all product development teams to meet weekly to review risks and ensure they have been accurately prioritized based on the latest assessment data, and to ensure that response plans are being developed and executed as needed.

STANDARD RISK MANAGEMENT TOOL

The unprecedented challenges of managing platform risks resulted in the opportunity to develop a single standard solution for use across all product development teams. The Corporate Risk Management team partnered with an internal team that develops validation tools who had a database product called "High Speed Database" or HSD. The idea was to enhance HSD to enable tracking risks across a complex environment consisting of many-to-many relationships. Further, we built the risk methodology and process into the tool that in turn drove and enforced the process.

Up until early 2005, all HSD-Risk instances were set up for ingredients; platforms were not comprehended in the tool. During 2005-2006, the HSD team developed and released a new technology called the virtual data engine that sits on top of HSD. This new technology provides the ability to address the complexity of many-to-many relationships between ingredients and platforms (Figure 5). Coupled with HSD's existing capabilities, the new technology provides an integrated, reliable, and measurable platform data management system that enables the capability to track and manage the health and quality of a platform and its ingredients as a cohesive unit throughout the entire product life cycle. HSD-Risk allows both ingredients and platforms a measure of customization in how the risk management processes are applied. It is the first tracking system at Intel that supports hierarchical platform/ingredient tracking.

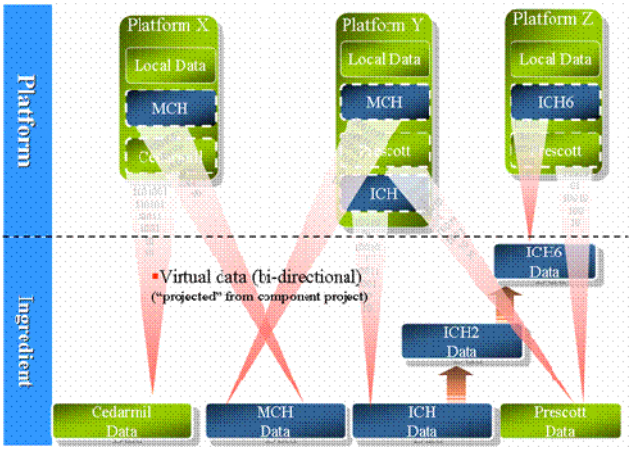

Figure 5: HSD virtual data technology

BEHAVIORAL CHANGES (ACTIVE RISK MANAGEMENT)

While successes were seen in the implementation of the risk management processes with the HSD-Risk tool, behavioral issues still persisted that were preventing good risk management processes from becoming widespread in Intel.

Mostly, we saw product development teams doing what we came to call "passive risk management." This usually meant that risks were generated one time at the beginning of the project, and then only updated for monthly/quarterly reviews with management in an effort to appear to be managing project risks. In reality, at the working level there was little more than fire fighting occurring. This kind of risk management is only window dressing, and in reality it drives very little improvement.

We advocate a simple approach that we call Active Risk Management to differentiate the desired state from previous passive risk management. This simple approach involves using HSD-Risk and a team commitment to do the following:

1. Carry out intact team training for the project team on the corporate risk management methodology, process, and tool.
2. Create a risk management plan that briefly describes how the project management team has agreed to deal with risk on their project.
3. Assign ownership (data entry, maintenance, accountability) of risks to the appropriate project person.
4. Commit to periodic reviews (weekly recommended) of the project risks by the project.

Since we have started emphasizing the increased communication, teamwork, and accountability behavioral changes necessary to perform active risk management, we have seen more examples of where teams can improve their chances of success. Success is defined as getting the project concluded earlier than it otherwise would have been with the potential of additional features. This comes about because active risk management is really driven by an increased emphasis on team communication and individual accountability.

RESULTS

The CPMO has implemented the active risk management process using the HSD-Risk tool on over 150 platform and ingredient programs throughout Intel with repeatable, measurable success. The first Intel® Centrino® processor technology platform development team to use active risk management was able to pull in their launch date eight weeks. Additional mobile platform teams were able to adapt to Microsoft's constant Vista launch changes, and were able to take a platform from concept to product in one year (typical platforms take three+ years).

Success with each of these programs was highly dependent on using the risk database, HSD-Risk, as a communication tool. Project managers used risk score cards generated by the tool to monitor potential problem areas in the project and focus their attention on these areas. In turn, the project team used the database to let the managers know what areas were headed for trouble. The program teams used valuable face-to-face meeting time to review the highest severity risks, ensuring the whole team understood the cause and possible impacts. They then created solid prevention, mitigation, and contingency plans for all involved stakeholders. Risk management became an integral part of the daily program management and a way to decrease fire fighting at major milestones.

The risks managed by each platform team varied greatly in scope and area (Table 2). The risk process was used to manage third-party deliverables, customer enabling plans, silicon stepping schedules, late validation boards, unit volume constraints, and marketing resources, to name but a few.

Table 2: Example platform risks taken directly from risk database

If problems with the new manufacturing process lead to the need for an additional quick stepping of the chipset, **then** the CPU tape-in would have to be delayed day-by-day from current commits to allow a minimum 1-week validation checkout with the chipset, ultimately resulting in day-by-day engineering sample delivery delays to the customers with current fab TPT commits.
If an application engineer is not committed for each platform ingredient by the closure of planning, **then** OEMs will not productize all ingredients at launch.
If third-party digital TV cards are not available to validation x weeks before qualification samples release, **then** TV usage models will not be adequately validated resulting in issues being found by customers late in the product development timeline and no healthy TV for launch.

For active risk management to become part of the project/program team's culture, the project/program manager must be a role model for the team. Most of these project teams have five to fifty key members for whom this process required behavior changes. In each successful example, the project managers asked to see the risk score cards on a regular basis. They requested that risks be entered in the database and kept up-to-date through the use of checkpoints. Most importantly, the project managers asked the right questions. They asked about response plans. They asked about true impacts and challenged risk data presented as well as the response plans to ensure robustness. The standard qualitative database fields for impact, probability, and time to action gave the project managers a method for more accurately weighing the severity of one risk against another. Managers were able to focus on the right risks, the ones with high impacts and high chances of occurring, without being influenced by risk adverse team members who spoke the loudest. Focus on the right problems leads to the biggest improvements, as 80% of the problems a project faces usually comes from only 20% of the risks.

This kind of role modeling led to mitigation and removal of a high severity risk on a core development project in Austin, TX. The engineering design manager closely monitored the top ten risk list and was instrumental in getting quick upper management approval for a large capital investment needed to prevent a coming bottleneck in verification testing. Following the active risk management processes, several individuals, layers of teams, and senior management worked together to raise and mitigate this risk until it was no longer a concern; this occurred several months before the risk would have negatively impacted the program.

The CPMO supplies project risk administrators to aid in the adoption of active risk management throughout the project teams. Risk administrators are responsible for setting up the databases, providing training to team members, and monitoring entered risks for quality. The risk administrator generates the score cards and other basic indicators on a regular basis.

Regular use of indicators from the risk tool provides a way for project managers to monitor risk management effectiveness and drive the right behaviors. Project managers look at the database's current status to see that all higher severity risks have response plans (Figure 7) and that all risks have update checkpoints indicating when more information will be available. Indicators showing risks over time are used to monitor overall trends, such as the severity of the risk over time (Figure 6), risks being closed out on a regular basis, and unexpected new risk spikes that occur because of decisions or events in the project ecosystem.

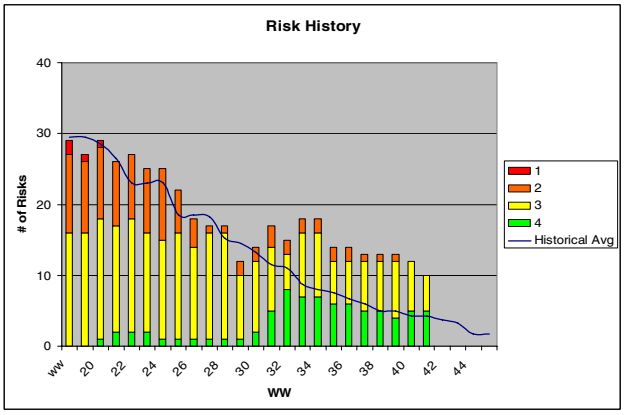

Figure 6: Sample indicator: trend of open risks by severity over time

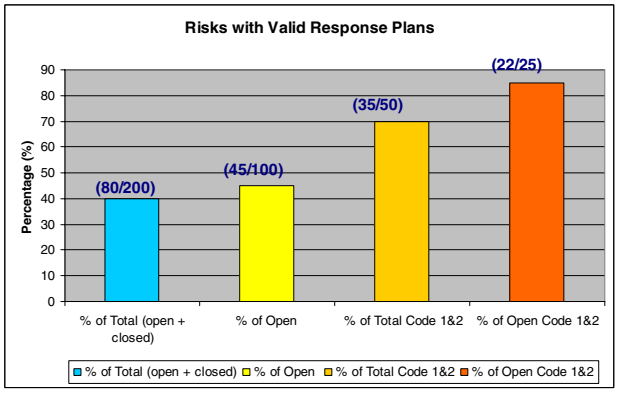

Figure 7: Sample indicator: risks with response plans broken out by all risks and high severity risks

One of the key indicators for the project manager is seeing risks closed as "avoided," instead of "resolved" or "realized" (Figure 8). Avoiding risks means the team is actively making decisions to take less risky paths that increase their confidence in hitting their commits, rather than just tracking a risk to resolution. Each risk that becomes realized is carefully scrutinized in post-mortems to understand how the team might have avoided it. These realized risks, as well as resolved and avoided risks, are extracted from the database and given to new projects starting with similar features and timelines to give project managers a head start on potential risks they may face.

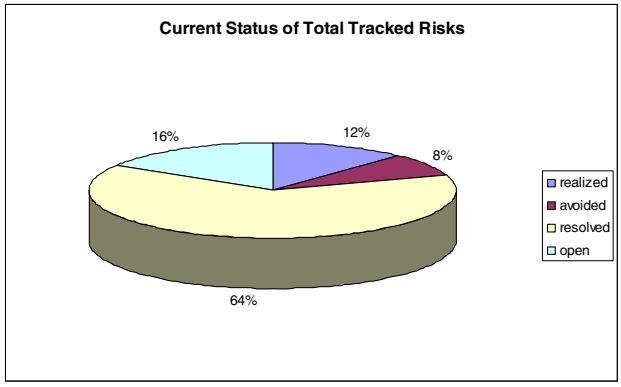

Figure 8: Sample indicator: current disposition of risks to measure risk management effectiveness

Within Intel's product development groups risk management is quickly becoming an integral part of platform program management. Team members expect to have risk databases in place for them to communicate risks, and project managers expect to have risk score cards and indicators available to help ensure high quality, on-time launches of high-risk, high-complexity products.

FUTURE OF RISK MANAGEMENT IN PRODUCT DEVELOPMENT

Risk practitioners will notice that we have described only qualitative techniques for risk management. When we first implemented risk management into product development we made the decision to avoid quantitative techniques to begin with because of the following reasons:

- Quantitative techniques tend to imply a level of accuracy and precision in risk management that simply does not exist. Engineers love their decimal points and will use them whenever possible. We felt it was important to first increase the development community's comfort level with the imprecision of risk management before giving them quantitative tools. We, therefore, developed an imprecise process that was good enough to get the job done.
- Many managers still struggle to see the bottom line value that risk management can bring to their project. Keeping the process quick, easy, and intuitive is a critical success factor in active risk management adoption in these project teams. Quantitative approaches tend not to have those qualities.

There is a future for quantitative risk management techniques at Intel. In 2006 we entered into our first test of managing schedule risk through a Monte Carlo simulation. The team uses HSD-Risk for their risk register and qualitative analysis. Risks are actively managed on a weekly basis and the project manager regularly reviews not only the status but the quality of the risks in the database. This environment was supplemented with the use of a schedule Monte Carlo simulation. The team collected 50% and 90% confidence level duration estimates. The estimates were entered into an add-on tool for Microsoft Project* using Beta distribution curves (Figure 9). Monte Carlo analyses were performed daily during the beginning of the project, then weekly, and now monthly, providing an ever narrowing range of completion dates (Figure 10). The data from the Monte Carlo simulations have supported decisions that allowed this team to pull in their schedules by 15 weeks from the original baseline of 92 weeks (about a 15% change). Their ability to quickly respond to changes in their environment through their thorough understanding of their schedule and risks is a key contributor to this achievement.

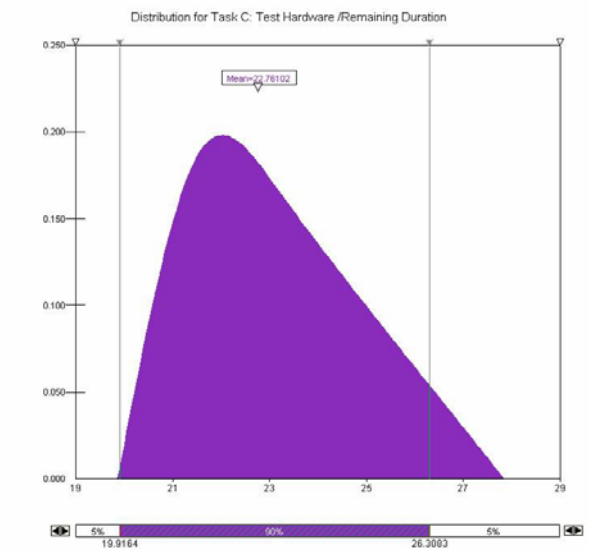

Figure 9: Monte Carlo task input distribution

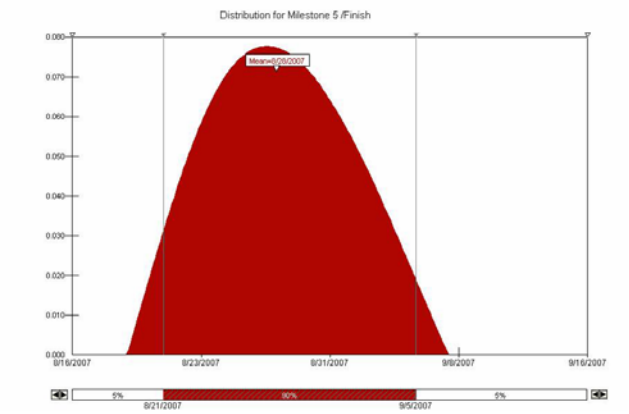

Figure 10: Monte Carlo Milestone Finish output curve

A second application of schedule Monte Carlo techniques led to an equally successful, although different, result. This project was for a product with very specific timeframes and features. Early on, the question wasn't "Is there a market?," but "Can we get it done on time?" The team assessed over 25 different what if combinations involving schedule, resources, delivery dates, and use of third-party vendors. Using the schedule Monte Carlo techniques they were able to comprehend the level of schedule buffer needed to absorb the amount of risk on the project. The project was too risky for the constraints given. It was cancelled in the planning stages, and the resources were applied to another development project with a greater potential for success.

Interest in quantitative techniques is growing with the success of these first two efforts. The future of quantitative risk analysis at Intel is bright.

CONCLUSION

Technology companies have a pervasive engineering mindset, which assumes that purely technical questions and issues are paramount. There is no question that solving technical problems was, is, and always will be one major key to Intel's success. The days when most managers believed that technical innovation is all that matters in their business success are coming to an end.

Intel has improved the predictability of its product development efforts through the implementation of a 6-Step Active Risk Management process and tool. The process provides a consistent language and approach to measuring risk. The tool provides risk visibility despite the many-to-many relationships that exist between Intel ingredients and platforms. Together, they promote inter-team communication with a bias towards proactively avoiding potentially costly risk events.

With the addition of quantitative techniques to Intel's repertoire of risk management techniques, we look forward to the day when schedule pull-ins are the norm and schedule slips the exception.

Active risk management is a goal well worth attaining. The costs are tremendous in product development projects with their sometimes several hundred person headcounts, empty factories ready to run the wafers based on a now late design, and marketing campaigns all primed to sell high-margin products. Finally, there is the future impact to other projects which were planning to use the roll-off resources. Clearly, the ability to finish a project sooner or with additional features is a great motivator.

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