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TEACHING NOTE

Teradyne Corporation: The Jaguar Project

Synopsis

This case examines Teradyne's implementation and use of new approaches to project management and project teams in the development of a new-generation tester, code-named Jaguar. The development involved significant hardware and software design. At the time of the case, Teradyne Corporation was a leading manufacturer of semiconductor test equipments. In 2001, the company started planning of Jaguar, a completely new tester platform intended to create a new system architecture that would form the basis of one of Teradyne's major product lines for the next decade. Strategically, this was a very important project for the company as the timing of the launch and performance of the product would have a significant impact on the company's revenues for years to come. Due to competitive conditions, time to market was viewed as a critical success factor.

Since 1996, Teradyne had been engaged in a multi-year effort to improve its product development capabilities and performance, and had adopted various tools and concepts such as aggregate project portfolio planning, product line road mapping, phase gate reviews, more integrated project team structures, and post-project reviews. The company reported mixed success with the implementation of these methods. One of the lessons learned from previous projects was that failure to properly plan project scope and deliverable timelines were root causes for project delays.

For Jaguar, it was decided from the beginning that the project would build on the existing concepts but also implement a more detailed and rigorous up-front planning and make use of tracking and reporting tools. The hope was that this approach to product development would facilitate the identification and corrections of problems in planning, tracking and controlling the development of the Jaguar project so as to ensure the delivery of a high-quality product *on time* and *within budget*. The case invites discussion of the effectiveness of this approach and the general lessons for the management of product development and project execution strategy. In managing the Jaguar project, the approach Teradyne used was very rigorous. Yet, part of the project failed.

Students must decide whether the rigorous approach Teradyne used was appropriate for the company given that Jaguar was a highly complex project involving both software and hardware development. The case discussion requires the students to explore the links between product

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This note was prepared by Post-Doctoral Fellow and Lecturer Francesca Gino and by Professor Gary Pisano for the sole purpose of aiding classroom instructors in the use of "Teradyne Corporation: The Jaguar Project," HBS No. 606-042. It provides analysis and questions that are intended to present alternative approaches to deepening students' comprehension of business issues and energizing classroom discussion. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

development, project management, and potential behavioral biases causing unintended consequences in the use of project management tools.

Purpose

The case examines the implementation of project management tools for the new product development process at Teradyne Corporation. Discussion of the available project management tools and approaches allows the students to understand not only the benefits and usefulness of rigorous project management processes but also the potential unintended consequences of the introduction and implementation of such tools. The decision about what tools should be used also allows the students to understand and explore why different project management tools and approaches may be more or less appropriate within specific organizational and strategic settings.

In general, despite the existence and availability of advanced project management tools, there is widespread evidence that product development projects are consistently late. The traditional approach to the problem is to develop better models for project management and more sophisticated in-process management tools (such as real time scheduling and earned value progress charts) and to undertake more planning activities. The case allows the student to understand when and under what conditions this is in fact a good approach.

This case has been taught in both elective MBA and executive courses on product development and operations strategy. It can be used in different modules of these courses, depending on whether the instructor is interested in specific discussions of project execution strategy and project management tools or more general lessons concerning the management of uncertainty in product development and the company overall approach to product development and learning.

Themes

The Teradyne case supports discussion of four central themes:

1. *Project Management Tools*: In project management, companies face a range of choices. What tools should they implement to plan, track and control the development of their projects? Which of these activities can they conduct without the implementation of appropriate tools? What characteristics of the tools or approaches to project management are they looking for? What are the pros and cons of using a rigorous approach to project management? Preferences about such choices constitute the company's approach to project management and product development. The case can be used to explore these choices and to understand the possibilities or alternatives involved in each of them.

2. *The Tension between Flexibility and Discipline in Project Execution*: Teradyne's implementation and use of a rigorous approach to project management needs to be examined by considering the two parts the Jaguar project involved, namely hardware vs. software. In a complex project like Jaguar a company may actually need multiple execution strategies: while part of the project might need discipline and the tools can be used to induce it, another part might need flexibility and the tools are then not appropriate. Thus, the choices about when and how to use (more or less advanced) project management tools might differ based on the characteristics and parts of the project being developed. The case can be used to explore this possibility and to understand how an organization can manage both discipline and flexibility inside the same project.

3. *Dynamic (Learning) vs. Static (Project Execution):* When should a company introduce and use advanced project management tools? With Jaguar, Teradyne introduced for the first time an extremely rigorous project execution strategy, which included up-front planning, less autonomy, tightly specified processes, and senior management attention at the front-end. The value of project management tools increases over time. For instance, an organization can only get better at estimating how long a certain task will take by forcing itself to use the tools. The first time tools are used, estimates will not probably be very accurate. The case invites discussion on how an organization can build capabilities in using these tools so as next projects would benefit.

4. *Behavioral Issues in Project Management*: The case invites discussion about a deeper issue facing most organizations introducing a new process or technology that change 'how the work gets done' within the company. What should the senior management do to make sure that project management tools are properly used? What are the potential unintended consequences of using these tools? When and why do unintended consequences take place? Teradyne seemed to have anticipated and responded to many of the common implementation problems reported in the literature. First, the company's senior management clearly demonstrated a capacity to invest in a disciplined up-front planning process and to avoid the firefighting phenomena. Second, senior management attention was focused early on the project, and senior executives (above the project team level) together with the project leader were strong "believers" in the project management tools being implemented. Finally, the company allocated extra resources to make sure the tools could be implemented. The bulk of the "extra work" for utilizing the tools was assigned to the program managers, who were well trained in the principles behind the tools and their use. Yet, while the tools worked well for the hardware part of the project the same did not happen on the software side. Through the discussion of possible reasons for this difference in both use and performance of the tools based on 'project type,' students can begin to gain an understanding of the role of behavioral biases in the implementation of new processes and tools, the sources of failure and success in both their implementation and use, and the implications for project management.

Suggested Reading Assignment

There is additional reading material that the instructor will find very helpful in preparing the case. Some of the material can be assigned as additional (optional) reading to students.

- Bazerman, M.H. (2005). *Judgment in Managerial Decision Making*. New York: Wiley. The book describes and discusses common biases documented in the psychology and behavioral decision making literature.
- Wheelwright, S. and Clark K. (1992). *Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency, and Quality*. New York, NY: The Free Press. Among other themes, the book discusses some common implementation problems in product development.

Suggested Assignment Questions

1. Compare and contrast Teradyne's traditional project execution strategy to the approach it used in Jaguar? What was similar? What was different?

2. What impact did the project management tools have on the Jaguar project? Specifically, how did they change behavior? How did they influence performance?

3. What were the unintended consequences of using the project management tools? What lessons should Teradyne take away from the Jaguar project?

Analysis

1. *Approach to Project Management at Teradyne*

Historically, like many other organizations, Teradyne was often not rigorous in deciding which features to include in a product (and thus often tried to undertake too much) and the budgeted timelines for activities were often not realistic. Moreover, the leaders of project teams and senior management often did not have very timely information on how a project was tracking relatively to schedule. While there might have been a sense that a project was beginning to slip, hard data were generally not available until after a major phase review but by this point it could have been too late to take corrective action. For the Jaguar project, a very rigorous approach to product development was used. In particular, the following specific concepts and tools were implemented:

- **Intensive Concept Development and Planning Phase:** The project team was required to develop an in-depth project plan (including target specifications, performance, and features) based on both technical considerations and market requirements. In addition, the team was pushed to identify all the critical technical risks and to provide contingency plans for managing those risks. Senior management did not approve funding for the project until a clear and thorough plan was in place. In fact, the first was plan for Jaguar was rejected, and the team was sent back to obtain more data. The final project plan consisted of a 75-page presentation.

- **Integrated Project Team Structure:** The development of a semiconductor tester requires the parallel development of a number of sub-systems: architecture, software, application specific integrated circuit, board design, cooling, device handling, user interface, etc. Sub-teams were assigned to each major sub-system. To ensure the required technical integration, a core team was created that included all the heads of the sub-teams. The engineering part of the core team reported directly to a senior manager who had overall responsibility for the project. The core team, consisting of some of the companies most experienced and technically adept managers met weekly via teleconference, and monthly in person to discuss progress, identify problems, and to make decisions regarding the execution of the project.

- **Project Planning and Management Tools:** To help ensure that the project team had the data it needed to make decisions, a set of formalized project planning and management tools were implemented on the Jaguar, including work breakdown structures, timeline estimations that incorporated uncertainty, critical path analysis, and earned value analysis. To ensure up-to-date information on the timing of the project, scheduling data were inputted into a web-based scheduling package (called Primavera). The schedule for Jaguar incorporated approximately 15,000 separate tasks. To provide an organizational infrastructure to execute the project planning and management process, a "program management" function was created. Each sub-team and the core team had a program manager responsible for making sure that the project planning tools were being used, the data were accurate, and the information made available to the project team.

2. *The Jaguar Project: Project Management Tools*

The project leader has proposed that for the Jaguar project all teams involved should use a rigorous approach to project management including the use of advanced tools. This proposal was based on his belief that tools would provide "discipline" to the process. Yet, from the comments reported in the case, there appeared to be conflict within the organization about the usefulness of the tools. While some members of the Jaguar team embraced the program management tools, others strongly resisted, or simply ignored them.

A. Those siding with managers in support of the tools might argue the following:

1. **Identification of Problems:** The tools used in developing and managing the Jaguar project helped the management to spot problems early in both hardware and software.

2. **Visibility:** In reflecting on the impact of the tools on hardware development, managers credited the tools with providing "visibility" into critical problems and enabling the team to respond. Weekly project reviews often resulted in changes to hardware development in order to optimize the critical path.

3. **Availability of Information:** Rather than making the team rigid, the tools were credited with providing the information needed to respond rapidly to external changes (such as the demands of one customer, "Alpha Tech," to ship a version of the product much earlier than schedule). One manager noted, "The tools provided visibility into the project we never used to have. This allowed us to respond to Alpha Tech and be confident that we could hit all the milestones."

B. Those against the tools might mention:

- **Impact on Behavior:** The tools worked the same way for software—i.e. provided visibility—but did not lead to the same impact on behavior. Several managers noted that the problems with software were evident from the beginning by the organization did not react. The project leader reflected: "Our problem was not lack of data but it was data staring at us, and us not responding" (page 12 of the case). Echoing a similar sentiment another project team member commented, "The tools allowed the software team to lie to themselves. They kept re-jiggering the critical path, putting things in parallel, adding resources, etc. to make it fit. Some very strong people allowed themselves to be fooled by the data. Jack (the project leader) let the metric lie to him. The software disaster was evident from the EV (earned value metric) but we ignored it" (page 12 of the case).

3. *Assessing the Performance of the Jaguar Project*

The Jaguar project involved both hardware and software development. In terms of the distribution of effort, hardware accounted for approximately 75%–85% of the total engineering resources invested in the project. Past projects had experienced significant delays due to hardware problems, and in particular the development of highly complex application specific integrated circuits (ASICs) that formed the electronic heart of the systems. Design problems found late in the development process had routinely delayed their completion. Since these devices were often on the critical path, these delays resulted in system launch delays. On Jaguar, the hardware part of the project was generally executed according to plan. The major hardware systems met their timelines and hit their specification targets. The five ASICs developed for the project came in largely on time

with no major design problems. Moreover, the project team responsible for hardware was able to respond to a significant shortening of the project time line made in response to a major potential customer request.

The software part of the project presents a very different picture. The software development effort began to run late from the beginning and never caught up. Even worse, when the project timeline was compressed, the problems of the software development effort were exacerbated. The project was described as falling to a classic "firefighting mode." To make up for lost time, the software team cut back on testing; however, this lead to more bugs in the code which further delayed the effort. As the project wore on, and became later, a significant additional software resources were added. The head of the software development effort was replaced and a new one was put in charge to complete the effort. The software completed about six months behind schedule and lead to a delay in the shipment of the first commercial systems.

4. *Differences in Performance between Hardware and Software: Explaining the 'Software Disaster'*

The project management tools Teradyne put in place in the development of the Jaguar project were designed to provide information—early warning of problems—that could help the project team respond. And, by virtually all indications in the case, the project tools performed this function equally well for both hardware and software. That is, tools like critical path and earned value analysis spotted problems early in both hardware and software. The tools did provide the data needed for decision making; but in one case, this led (apparently) to corrective action; in other, it was followed by inaction.

Lurking behind these differences in use and performance following implementation of the tools are different organizational competences in hardware vs. software design and development. Understanding what these differences are helps to explain the software disaster, and may offer reflections on what to change for future project development efforts. We summarize the potential explanations for the software disaster below.

- *Hiding Bad News*: It is not unusual in any complex, multi-component development project to have some parts of the project run considerably better than others. Differences in organizational capabilities, the complexity of technical requirements, and luck may explain why hardware performed according to expectations and software did not. One of the common pathologies in development projects is the tendency for participants to hide "bad news" (technical problems, delays, etc.) from superiors. For example, this tendency has been noted in studies ranging from the Challenge and Columbia space shuttle disasters (Edmondson, Ferlins, Feldman and Bohmer, 2005; Vaughan, 1996) to the failure of organizations to implement improvements in product development processes (Ford and Sterman, 2003a; 2003b). Organizational conditions, such as those influencing "psychological safety" (Edmondson 1996; 1999) or the willingness of subordinates to speak up, have been identified as lying at the root of this problem. Interestingly, in the case of Teradyne's software issues, this problem does not seem to be at work. The data were visible. No one seemed to intentionally hide information about problems. The "re-jiggering" of the schedule was evident to everyone, including the project team leadership.
- *Misalignment of Incentives*: In many projects, functions (e.g. software) have incentives to optimize their own goals at the expense of overall project goals. This generally occurs when organizational structures and incentives are not in place to align the motives of project participants. That does not seem to have been a factor in the Jaguar project. A

relatively hierarchical "heavyweight" type structure was in place with sub-team project leaders reporting directly to the overall project leader. This enabled cross-functional issues to be raised and addressed relatively quickly. In addition, there was no evidence of trade-offs being made between making the hardware simpler to design at the expense of creating more complexity and work for software.

- *Structure of Hardware vs. Software Design*: Software is less concrete, and therefore more malleable than hardware. The system imposes physical constraints on the design process, and several managers noted that characteristic facilitates a more structured approach to hardware development. While there is little doubt that hardware and software constitute structurally different technologies, the structural difference between the two does not offer a fully satisfactory explanation to the 'software disaster.' It is possible to prototype software, to test these prototypes, and thus to assess progress based on the convergence of the code to certain features and to specified levels of quality (McConnell, 1996; MacCormack, 2001). And, it is possible to structure the development of software. Software may not be physical, but it is no more difficult to test whether code in process is converging to a desired level of performance than it is to asses whether a hardware design is progressing as planned.

- *Organizational Competence and Experiences*: The content and complexity of software used in semiconductor testers, like virtually all other electronic systems, has increased exponentially in the several years. Teradyne, like most other companies in the industry, has far deeper technical experience and technical competences, in hardware design than software development. Even in the Jaguar project, software accounted for only about 10% of the resources invested in the project. And, all but two of the core team leadership had backgrounds in software, the rest were trained in various "hardware" engineering disciplines (e.g. electrical engineering, mechanical engineering, etc.) and had spent their careers engaged in hardware design. Thus, in terms of pure technical experience and competences, Teradyne was clearly more oriented toward hardware than software. This difference in competences might have implications for behavior. The conclusion would be that the difference in competences explains the difference in performance; they did well where they "knew what they were doing" and did poorly where they did not. But the puzzle is not about their performance per se, but the apparent effect of the project management tools on performance. The company, despite its deep technical expertise in hardware, had struggled on previous projects with time overruns, the discovery of design problems late in the process, and other issues.

An alternative explanation to the "software disaster" is based on a potential interactive effect between the behavior in using the tools and organizational competences. Organizational competences might have a moderating impact on the effect of the tools on users' behavior. More specifically, where an organization has strong organizational competences, the tools may reinforce desired behaviors, such as rapid response to information. On the contrary, where an organization has weak competences, the tools may reinforce undesirable behaviors, such as procrastination bias and cognitive dissonance. In the Jaguar project a combination of cognitive dissonance and procrastination proved fatal:

(a) *Cognitive Dissonance*: The failure of the team to react to the data would seem to be a manifestation of cognitive dissonance (Festinger, 1957): Dissonance results from receiving information that is inconsistent with something one believes to be true and important about the self. In the case, there might be an inconsistency between the possibility that information provided by the tools may actually be unhelpful,

and believing oneself to be a rational person who works efficiently and can "catch up" with the work in case of project delays. Team members might avoid or resolve this inconsistency by developing a view of the information as less worthwhile than they otherwise would. The implication of this is that no action is taken based on such information.

(b) *Procrastination*: This is the tendency to postpone tasks repeatedly over time: "Procrastination occurs when present costs are unduly salient in comparison with future costs, leading individuals to postpone tasks until tomorrow without foreseeing that when tomorrow comes, the required action will be delayed yet again" (Akerlof, 1991: 1).

According to this explanation for the software disaster, behavioral and cognitive factors have a different influence based on how strong the organization competences are. With Jaguar, by and large, the same group of core team project managers was involved in the critical decisions for both the hardware and the software parts of the project. For decisions and issues regarding hardware they behaved in a way that appeared quite rational. They looked at all the relevant data, they sorted out signal from noise, they grappled with trade-offs, and they responded relatively quickly. The project management tools appeared to help them in this process. In contrast, for software, this same group of managers looked at the data, questioned its veracity, and then failed to act even in the face of mounting evidence (both from the formal metrics and their observations of the project) that this part of the project was seriously behind schedule—and with knowledge such a delay would be costly. In essence, we have an organization displaying a metaphorical "split personality": (apparently) rational with respect to one set of issues and decisions, and biased and cognitively limited with another set.

Teaching Suggestions

The instructor should start class by asking for an assessment of the Jaguar project. For example, the opening question could be "What is your evaluation of the Jaguar project?" or "How did the Jaguar project perform?" As the students discuss the strengths and weaknesses of the project, it can be helpful for the instructor to list the elements which were part of Teradyne's approach to project management—use of advanced project management tools, staffing and project teams, hardware and software, decision making (see **Exhibit TN-1** for an example). Depending on where this case is taught in a course and the specific pedagogical goals, the instructor can spend some time discussing these elements, their evaluation and their fit with Teradyne's overall approach to product development and strategy of project execution (e.g., What are the advantages in using tools such as critical path or earned value analysis? What are the implications of having so many project teams, working in different locations around the country?) If the class is not familiar with the project management tools Teradyne implemented with Jaguar, it is worth spending some time making sure the students know what these tools are about and how they work in practice. A summary of the working of the project management tools is also provided in the case, in **Exhibit 4**. The instructor can refer to it. Generally, this part of the discussion should take no more than 10 minutes.

In the next 10 minutes, the instructor should focus on the project management tools Teradyne implemented with the Jaguar project. The discussion could start by asking "How helpful were the tools?" As the students discuss the pros and cons of the project management tools, it can be helpful for the instructor to list the comments under two different categories: the ones in support of George Conner's view (e.g., not helpful, distracting) and the comments in support of Jack O'Brien's perspective on the usefulness of the tools (e.g., forced discipline, provided data). A nice debate can be stimulated by using this distinction and by asking students which view they support and why.

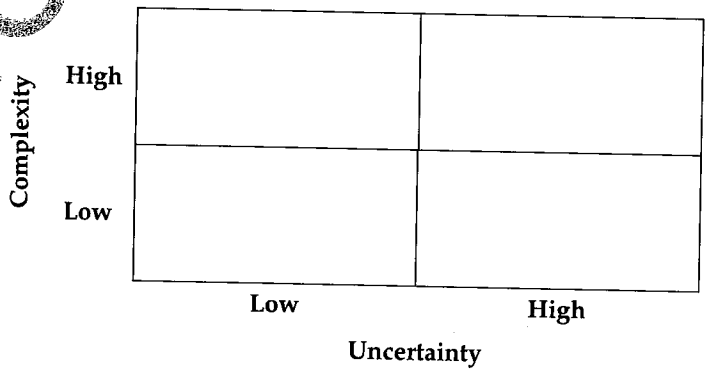
The instructor should then turn to a deeper discussion on Teradyne's project execution strategy. This discussion can easily take 40 minutes as students debate the fundamental tension between flexibility and discipline in project execution. How can an organization build in necessary flexibility without inducing 'sloppiness'? This discussion can start by comparing Teradyne's traditional project execution strategy and the one used in the Jaguar project. It can be helpful to graphically organize the comments using the following table.

	Teradyne's Traditional Project Execution Strategy	Execution Strategy Used in Jaguar
Planning		
Engineers' Autonomy		
Process Flow		
Senior Management		

The instructor can use this table to easily compare the project execution strategy the company traditionally used vs. the one used with Jaguar. The discussion should highlight the elements reported in **Exhibit TN-2**. During this discussion the instructor should be trying to highlight some of the features of the Jaguar project, in particular its complexity. In developing a complex project can an organization use just a single project execution strategy? A potentially sharp debate can be triggered by asking whether flexibility and discipline can both be managed inside the same project. Some will support Jack O'Brien's view and argue that enforcing discipline with the implementation of project management tools does not impact the level of flexibility in the development process. Others will see it very differently. They will support Krieger's point of view and argue that uncertainty in inherent in the product development and thus a low level of discipline is necessary to allow flexibility.

At some point, the instructor should help the students understand that the trade-off between flexibility and discipline can be resolved with a contingent approach: different environments or sub-projects might need a different focus (priority to flexibility vs. discipline) and the tools should be applied based on this distinction. It can be helpful to start the discussion by drawing the matrix reported in **Figure TN-A** and asking the students to mention environments or firms which would be placed in one of the quadrants.

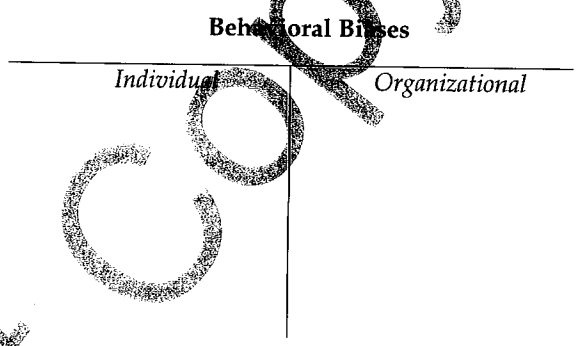
Figure TN-A. A contingent approach to the trade-off between flexibility and discipline.



For instance, chip and software development are examples of both high complexity and high uncertainty. Once there are examples written in each quadrant the instructor can ask the question of

where the project management tools work and why. This s a critical point in the class, as it shifts the discussion to an important topic, which is the usefulness of the tools. The instructor might want to draw the same matrix but this time each quadrant will report the benefits or costs in the use of the tools. For example, in an environment or project characterized by low uncertainty and high complexity, among the benefits the students might mention the fact that tools allow coordination and the scheduling of risk. At this stage, the instructor should try to get the students to articulate the different uses of the tools in each quadrant, focusing in particular on the case of highly complex projects or environments (given that this was the nature of the Jaguar project). In such a case, when uncertainty is low, the tools can be applied to induce discipline and execution (conformance). Instead, when uncertainty is high, the tools can be applied to induce learning (innovation).

The final 20 minutes of class can be spent reflecting on the behavioral issues lurking in the case. Questions that the instructor can ask during the discussion are: What are potential explanations for the software disaster? Did Teradyne select the right set of tools? Was Teradyne using the tools appropriately? Why or why not? What are some of the reasons why the organization did not react? What was the impact of the tools on behavior? Here, the instructor can describe some of the behavioral biases that could have played a role in the software disaster, such as psychological safety, procrastination, or planning fallacy. It can be helpful to organize these behavioral biases by distinguishing two levels: individual and organizational, as reported in the graph below. The discussion should highlight the biases reported in **Exhibit TN-3**.



The instructor can also ask the students to think about the lessons learned with the Jaguar project. What is their recommendation for the future? Should Teradyne continue using the EPIT process for all product development projects? What changes should the company introduce? In asking these questions, the instructor can push students on their answers and ask them to defend their position by considering both content and implementation strategy.

The instructor can then summarize the discussion by noting that issues of project execution strategy are a very important part of a company overall approach to product development. There are trade-offs inherent in project execution strategies, such as the tension between flexibility and discipline. And the use of the tools should change based on the focus a company chooses in its project execution strategy. The instructor should also notice that it is important for the organization to understand the potential biases that might affect its project management approach. The tools can be used in a way that helps counteract such biases.

A proposed board plan for the above discussion is provided in **Exhibit TN-4**.

Exhibit TN-2a. Summary of Teradyne's Project Execution Strategy used in the past vs. in Jaguar.

What lessons?	Element valued	Fit between the components
Project Planning	Value of planning	Careful planning, defined scope
Project Team	Value of using cross-functional teams	Heavyweight teams, distributed
Project Management Tools	Value of discipline?	Increased speed?
Design - Testing	Value of heavy testing	Early testing, early availability of information
Senior Management Review	Value of early focus	Continuous reviews
Mid-course Corrections	Value of information	Pressure

Source: Casewriters' analysis.

Exhibit TN-2b. Summary of Teradyne's Project Execution Strategy used in the past vs. in Jaguar.

	Teradyne's Traditional Project Execution Strategy	Execution Strategy Used in Jaguar
Planning	Little up front	Up-front planning
Engineers' Autonomy	High	Low (at least less)
Process Flow	• Not tightly specified (major phases • Little formal tracking	Tightly specified process
Senior Management	• More focused on back-end of program • Problem-Solving	Attention at front-end

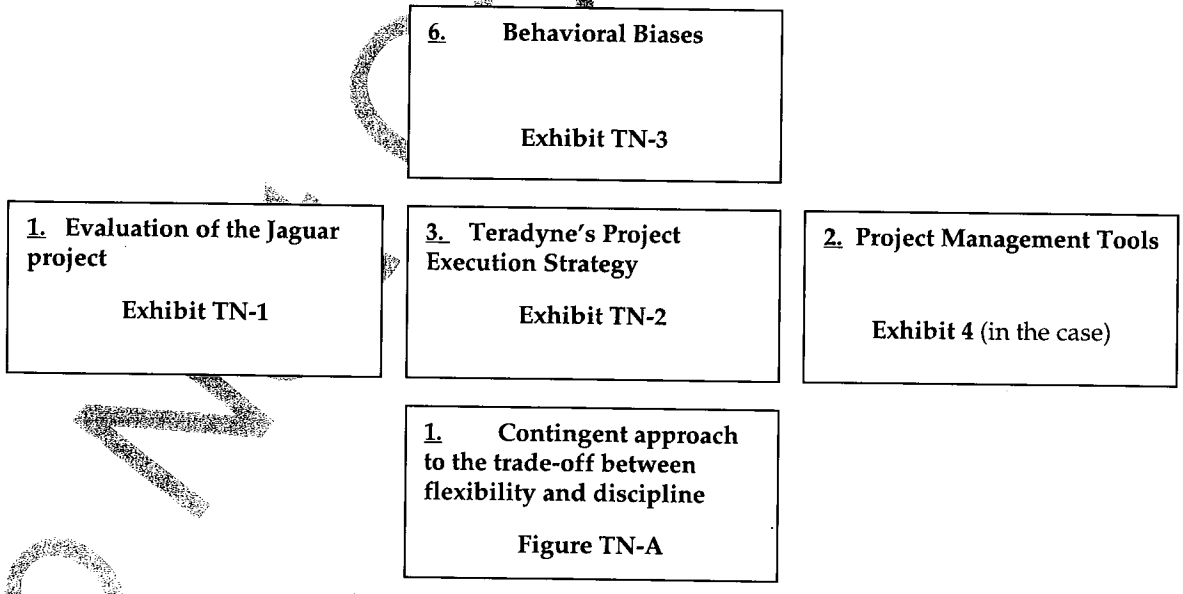
Source: Casewriters' analysis.

Exhibit TN-3. Summary of behavioral biases.

Behavioral Biases	
Individual	*Organizational*
Focusing failure	Psychological Safety
Boiling Frog	Accountability Bias
Procrastination	
Confirmation Bias	

Source: Casewriters' analysis.

Exhibit TN-4. Proposed board plan.



Source: Casewriters' analysis.

References

Akerlof, George (1991). Procrastination and Obedience. *American Economic Review*, **81**(2): 1-19.

Edmondson, Amy C. (1996). Group and Organizational Influences on Team Learning. Ph.D. Dissertation. Harvard Business School. MA.

Edmondson, A. (1999). Psychological Safety and Learning Behavior in Work Teams. *Administrative Science Quarterly*, **44**(4): 350-383.

Edmondson, A., Erika Ferlins, Laura Feldman, and Richard Bohmer (2005). *The Recovery Window: Organizational Learning Following Ambiguous Threats*. In Organization at the Limit: Lessons from the Columbia Disaster, edited by M. Farjoun and W. Starbuck. Blackwell.

Festinger, L. (1957). *A theory of cognitive dissonance*. Stanford, CA: Stanford.

Ford, D. and J. Sterman (2003a). Overcoming the 90% Syndrome: Iteration Management in Concurrent Development Projects. *Concurrent Engineering: Research and Applications*, **11**(3): 177-186.

Ford, D. and Sterman, D., (2003b). The Liar's Club: Concealing Rework in Concurrent Development. *Concurrent Engineering*, **11**(3): 211-219.

MacCormack, Alan (2001). Product-Development Practices that Work: How internet companies build Software. *MIT Sloan Management Review*, Winter, **42**(2).

McConnell, Steve, (1996). *Rapid Development: Taming Wild Software Schedules*. Microsoft Press.

Vaughan, Diane (1996). *The Challenger Launch Decision. Risky Technology, Culture, and Deviance at NASA*. The University of Chicago Press.