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Matching project managers with project properties

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ABSTRACT

Research is conducted to determine which characteristics in project managers align well with characteristics in new product development projects. Projects are characterized in terms of both managerial and technical complexity. Project managers are characterized using principles established in by Hauschildt, et al. Relationships are established between the two.

THE PROBLEM

There has been ongoing research that has concluded that project managers have a positive effect on project performance. Knowing this, many firms have adopted project management practices and disciplines to their new product development process. However, in order to optimize the chances of success, a firm may want to match the right project manager with the right project. A large firm may have multiple development projects in process. Accordingly, they will also have several project managers to lead these projects. The next logical step would be to assign project managers to each of the projects. This decision can be critical. Not having the right person for the job may lead to wasted effort, increased time to market, and sub-optimal results in new product introduction.

A manager's dilemma is to determine what traits each project manager possesses and how they add (or subtract) to the success of each one of the development projects. Ideally, a manager can create project manager-project combinations that provide an optimal portfolio output similar to what Roussel, Saad, and Erickson propose. While this latter statement will not be addressed in this paper, the paper will address what combination of traits and capabilities in project managers match well with what types and characteristics of projects.

The purpose of this research is to provide a blueprint for the business unit studied for aligning project management traits to projects. The alignment will be based on empirical evidence of project success and the characteristics of those project managers involved in that success. The goals for this research are as follows:

- Define "success" for the projects in the business unit in question.
- Define a superset of traits and/or characteristics of project managers in this business unit.
- Quantify the skill set in each project manager.
- Classify the projects in terms that correspond to certain project management traits or characteristics.
- Analyze the relationships between the traits in each project manager, the characteristics of the projects themselves, and the relative success or failure of each project to determine what trait/project-type combinations increase the chance for success.

This research will provide managers of this business unit a more comprehensive view of the impact of project managers and what drives project success.

WHAT THE LITERATURE SAYS

There are two key areas in which literature has dealt with these topics. The first is determining what characteristics project managers need in order to make their projects a success. Thamhain and Wilemon (in Dinsmore 54-56) created an initial list of characteristics based on anecdotal data. They aggregated the skills and abilities into the following six categories: leadership, technical expertise, human skills, administrative skills, organization skills, and entrepreneurial skills. The common theme identified through all of these skills as noted by Dinsmore is "behavioral interaction".

Posner (in Meredith and Mantel 146-149) developed a commonly cited list of characteristics. In this article, Posner developed a list of the most common project management problems as indicated by 287 project managers during a nationwide series of project management seminars. He also compiled a list of the skills needed to be project manager. From these studies, Posner created the following six categories of skills ranging from most cited to lease cited: communication skills, organizational skills, team building skills, leadership skills, coping skills, and technological skills. Posner was then able to correlate the list of skills to the list of problems. It should be noted that Posner and Kouzes later stated that the best way to develop these skills was through experience (in Pinto 249-255).

Perhaps, Juergen Hauschildt, Gesche Keim and John W. Medcof wrote the key piece of literature in this area. They identified five types of project managers on successful projects and were able to determine what factors were most prevalent in these types. They broke the skills needed by project managers into seven factors: organizing under conflict, experience, decision-making, productive creativity, organizing with cooperation, cooperative leadership, and integrative thinking. Overall, the literature shows that a set of desired skills in project manager can be developed.

The second (and more elusive) key area of research focuses on project success. The most common analysis tool is the use of discounted cash analysis and specifically net present value (Meredith and Mantel 49-54). However, this is often used as a project selection tool and not as a formal analysis of work completed. Furthermore, Roussel, Saad and Erickson point out that, "the range of uncertainties for research reaching out more than a year or two is so substantial that the rigor implied by NPV or DCF considerations becomes not only meaningless but possibly harmful (97)."

Efforts to measure project success after the fact are very limited. Hauser advocates a mathematical approach using both financial and scoring measures (1673-1675). While the analysis is complete, it is not straightforward nor without significant (if not overwhelming) complexity. Firms taking up this model to analyze their development process would be hard-pressed to apply it.

Griffen, in her analysis of product development cycle time, seems to have started a framework for project success analysis that takes into account most of the determinants. She breaks up the variables into three categories. The first is labeled "project characteristics". This would include the complexity of the product (number of product functions, number of technical specialties) as well as the percent of change over its predecessor. The second measurement is of the outcomes. This can be both process related (such as cycle time) or product related (such as commercial success of customer satisfaction figures). The third category deals with development process variables. These would include the establishment of a process, the driver of development, as well as tools and techniques used in each of the projects. It is through this analysis that Griffen proposes a baseline for measuring performance of future projects. This article may provide the best framework for categorizing projects and measuring project success.

RESEARCH DESIGN

This research is focused on the Netcom SBU within Agere Systems (formerly the Microelectronics group of Lucent Technologies). This group specifies, designs, and manufactures semiconductors tailored for the communications equipment market. Their leading customers include Nortel, Cisco, and their parent company, Lucent Technologies.

The group has been using a stage-gate cross-functional process called XPReS. XPReS stands for Cross-functional (X) Product Realizations System and was brought into Lucent Technologies Micro Electronics Division (ME) in 1995 by the consulting firm, Pittiglio, Rabin, Todd, & McGrath (PRTM). XPReS defined the steps that had to be done in order to bring a semiconductor product to market. The foremost purpose of XPReS was to improve ME's product development performance in relation to its semiconductor competitors. The performance was to be measured in terms of time-to-market, profitability, development expense, and product innovation.

The XPReS Process is broken down into 5 phases. Phase 0 is defined as the marketing definition where the product's functionality is defined and the market identified. Phase 1 is the development of the product specifications. Phase 2 is where the design takes place. Phase 3 is when revisions to the product are finalized and the product is ready to be taken over by manufacturing. Phase 4 is when the product has successfully ramped to manufacturing. The Netcom SBU tends to emphasize time-to-market and product innovation over other considerations outlined by XPReS.

The research focuses on three analyses. First, completed projects were characterized based on both relative and absolute schedule adherences as well as complexity. Second, the project managers were rated using some of the skills identified by the empirical literature. Third, correlations are derived between these characteristics and the success achieved in meeting schedule. The research focused on those projects that are have achieved "Ready to Manufacture" status (RTM) and that have followed the XPReS steps.

SCHEDULE ADHERANCE

The primary job of a project manager in any new product development process is to deliver a product on time, within budget and to specification. The more a project manager understands the steps involved in the development process as well as what information needed to plan and execute, the more effective they will be at bringing the project in on-time, on-budget and to specification. For this analysis we shall look at three measures listed in the following table.

Table 1 - Project Time Measurements

Measure	Standard Product Definition
Design Time	Phase 1 Review Date to Phase 2 Review Date
RTM Time	Phase 2 Review Date to Phase 3 Review Date
Development Time	Phase 1 Review Date to Phase 3 Review Date

DESIGN TIME

Design time is when the project team is focused on the development of the product itself. The time starts when the team has determined the functionality of the product and begins to execute on its design. It ends when first prototypes are delivered and determined to be functional. The majority of the time is spent by development engineers making design decisions as to the best way to implement a product requirement. The project manager must focus the team on meeting the functional requirement and then moving on. Often times, an engineer might be looking for the most efficient or the most elegant solution, when in reality, the customer may or may not see these design idiosyncrasies. It would be expected then that project managers that succeed in this phase are those that are results-oriented and can also deal with the creative process.

RTM TIME

The time between first prototype availability and full manufacturing readiness is a time that may not be as glamorous as the time when design is occurring. However, this time is when a product becomes "ready to manufacture" (RTM) and therefore, makes the company money. Continual focus must be placed on qualifying the product, as well as delivering the necessary information and tests to assure product compliance. The design team must be focused on this while they might be prodded to start design work on the next development project. The project manager must maintain the attention of the development staff and drive the product-engineering group toward completion of all the qualification necessary to move the product into manufacturing.

DEVELOPMENT TIME

Development time is the time that includes both the design time and the RTM time. The project manager that does well at predicting and managing to this goal needs to blend aspects of product development; the creative side as well as the more straightforward tasks of introducing a product into manufacturing. Project managers who predict/manage to this goal are expected to be the crème of the crop.

PROJECT COMPLEXITY

A measure of complexity is not easy to determine. For the purposes of this research, we have used a figure of the number of people involved on the project. This takes into account the total number of disciplines as well as the total amount of work required to bring a product to market.

Project managers who deal with projects with above average complexity have larger networks that must be communicated to and synchronized. The project managers that succeed in delivering products with large amounts of complexity should be able to delegate and coordinate many different activities at once.

PROJECT MANAGEMENT CHARACTERISTICS

Hauschildt, et al identified seven factors of project management characteristics: organizing under conflict, experience, decision-making, productive creativity, organizing with cooperation, cooperative leadership, and integrative thinking (26). These break down into twenty-four variables. Each factor has a weighting of variables attached to it (27). To determine the amount of each variable each project manager has, a questionnaire containing twenty-four 7-point scales was delivered to each project manager. They rated themselves in all the variables listed in Appendix B – Hauschlidt's Factor Loadings. Project management factors are then identified using the factor loadings generated by Hauschildt, et al.

From this research we should be able to determine three sets of variables. The first is the characteristics of the project. This includes the predicted design time, the predicted RTM time, the predicted development time as well as the number of people involved on the project. The second set of figures is project outcome as represented by the three development cycle figures. The third set of figures is the measure of the seven factors that each project manager brings to the table.

Below is a summary of variables:

Table 2 - Summary of Project Variables

Project Characteristics	PM Factors	Project Outcome
• Predicted Design Time	• Organizing Under Conflict	• Design Time
• Predicted RTM Time	• Experience	• RTM Time
• Predicted Development Time	• Decision-Making	• Development Time
• Number of People on Team.	• Productive Creativity	
	• Organizing with Cooperation	
	• Cooperative Leadership	
	• Integrative Thinking	

The goal is to determine which factors, when coupled with certain project characteristics, will lead to a higher likelihood of project success. For instance, one might expect that project manager with higher levels of experience tend to have a higher likelihood of delivering projects on time with respect to RTM. Or, one might expect that project managers that have a greater ability to organize under conflict deliver more complex projects on time. Overall, there are a potential of 84 charts that can be generated using these factors. Linear modeling is used to generate relationships between each of the project characteristics and the project outcome.

RESULTS

TIME TO MARKET

For measures of time to market efficiency, a comparison was made between the predicted time to design and time to develop and the actual time to design and time to develop. All twenty projects studied are listed in Figure 1 - Time to Develop Accuracy, Figure 2 - Time to Design Accuracy and Figure 3 - RTM Accuracy. The trendline on both identifies the least squares fit analysis of these points.

Figure 1 - Time to Develop Accuracy

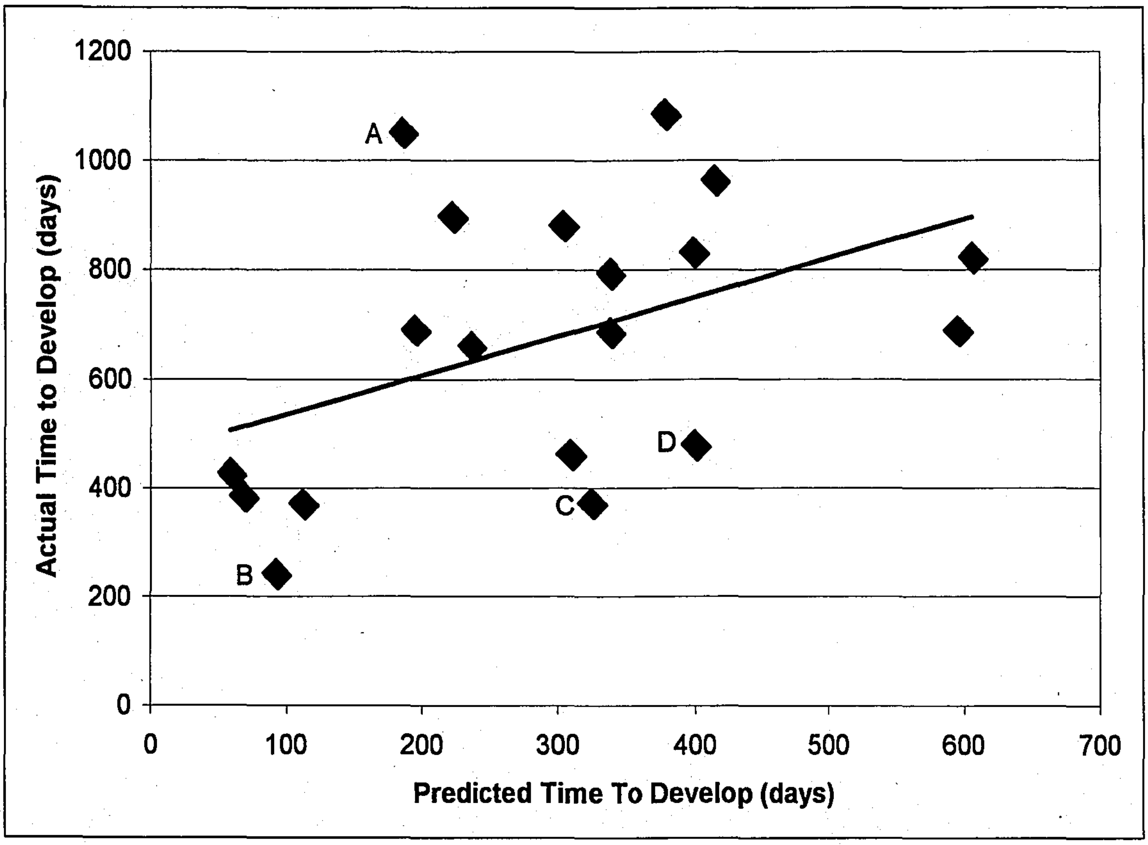


Figure 1 shows the relationship between the actual time to develop a project and the predicted time to develop a project. The point labeled A in the above shows a example of a disaster project where the time to develop was predicted to be approximately 200 days and the actual time to develop was well over 1000 days. While Project B is significantly better, it should be noted that error in prediction is still quite large (approximately 200% of prediction). In fact, only projects C and D were delivered with 20% of prediction.

Figure 2 - Time to Design Accuracy

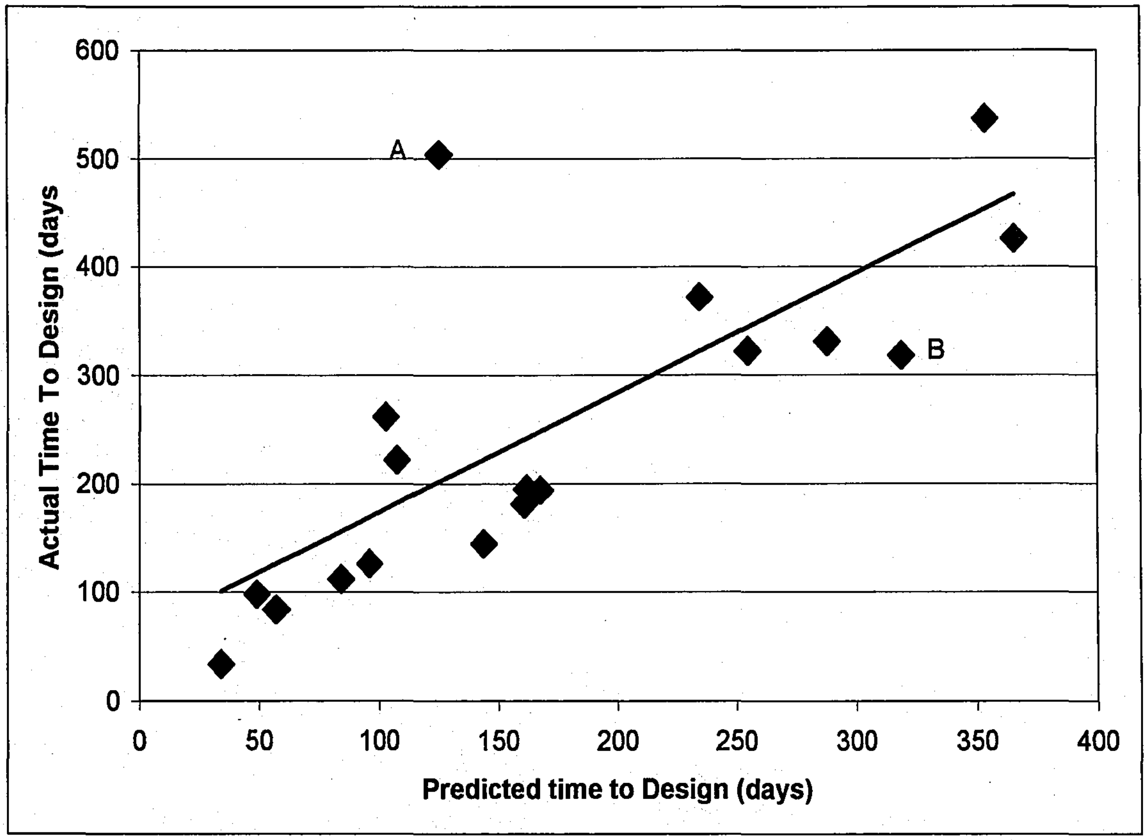


Figure 2 shows a less drastic, but similar story. It appears that project managers within this group have more control over the design time. However, project A still has a rather large error (500 days versus 125 days). Project B might be seen as the best case for on time design. The actual time has 319 days versus the predicted time of 318 days.

Figure 3 - RTM Accuracy

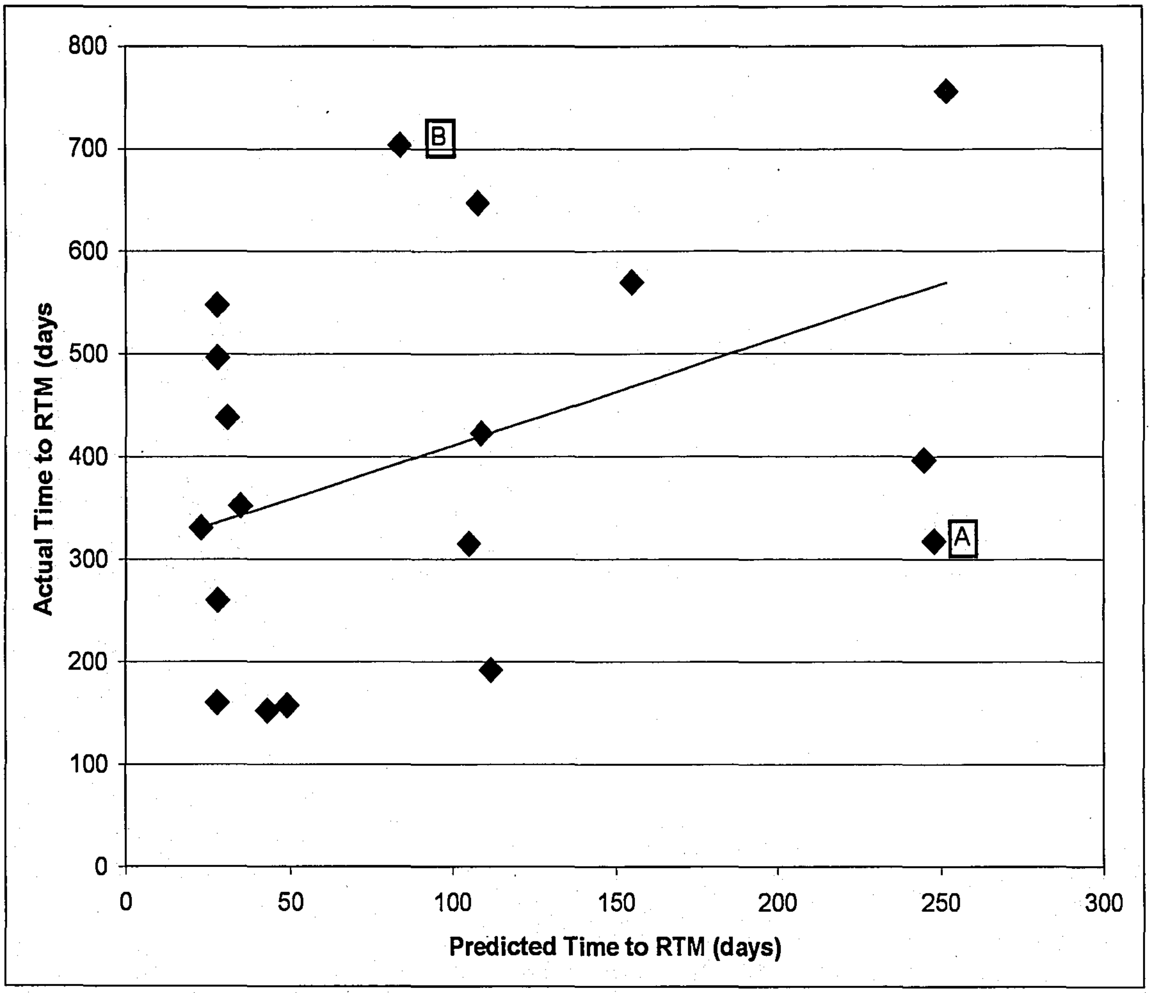


Figure 3 shows less correlation than the time to design (Pearson coefficient of 0.44 in the RTM chart versus 0.78 for the design chart). Furthermore, it is difficult to characterize any of these designs of having on time RTM. The best case occurs with project A which had a predicted time to RTM of 250 days and came in around 315 days. The worst case comes from project B, where the predicted time to RTM of less than 100 days and was delivered in more than 700 days.

It was then determined which of these projects (if any) met the following conditions:

Table 3 - Definitions for Time-to-Market Criteris

Condition	Definition	# of projects observed (N=20)
Better Than Average RTM	Those projects below the trendline on time to design	9
On-time Design	Those projects whose design time was less than 120% or predicted time to design	9
On time Development	Those projects whose development time was less than 120% of predicted time to develop	2

PROJECT COMPLEXITY

Projects were also looked at from a complexity viewpoint using the criteria established previously. On the twenty projects surveyed, seven of them were below the trendline of the graph shown below:

Figure 4 - Project Complexity

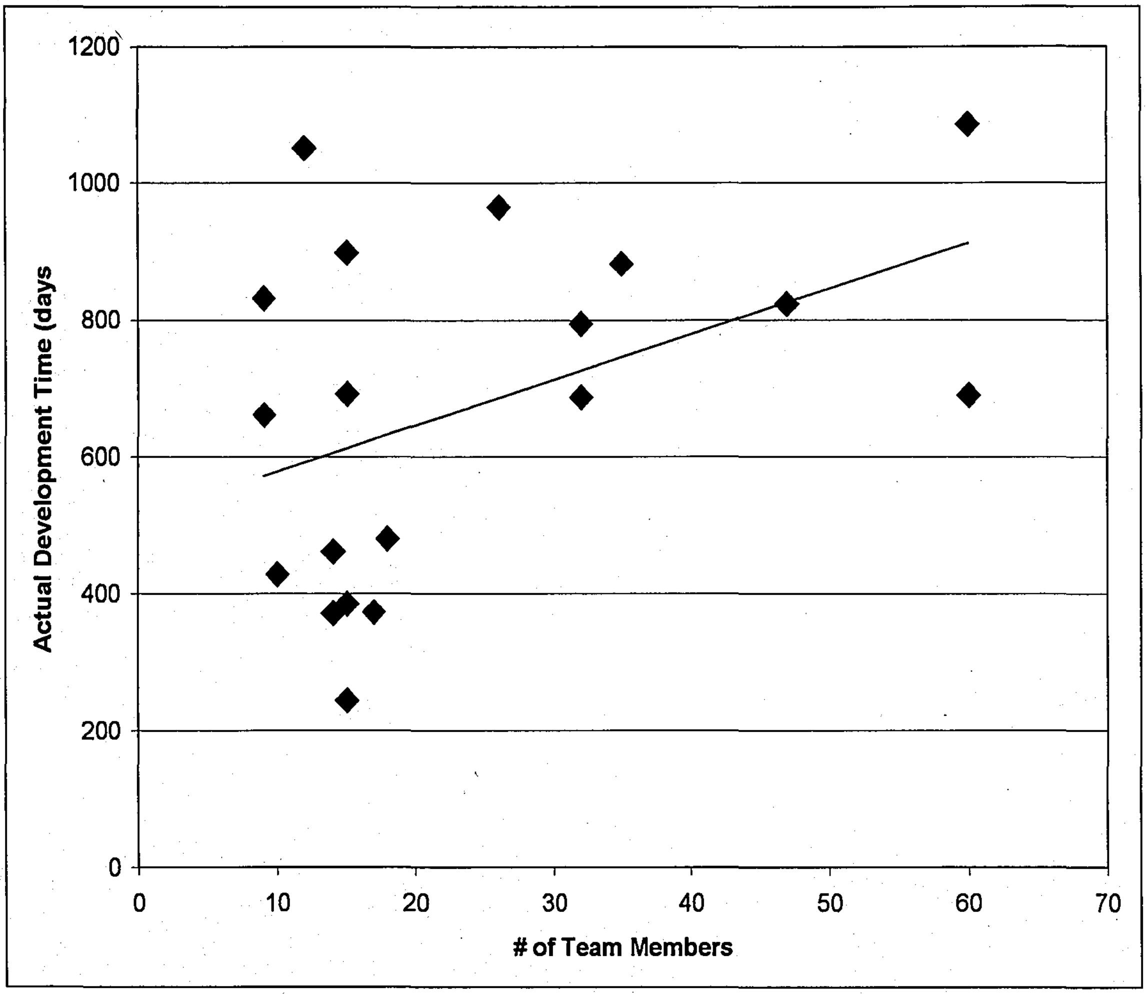


Figure 4 shows a similar level of correlation as the RTM or development figures (Pearson coefficient = 0.443). From this analysis, it was decided to look at only those project that were below the trendline (N=11).

PROJECT MANAGEMENT CHARACTERISTICS

Five different project managers ran the twenty projects surveyed. . The score were converted to factors using Hauschildt's factor loading table and then normalized to a 0 to 10 scale. The results are listed below:

Table 4 - Group Project Management Characteristics

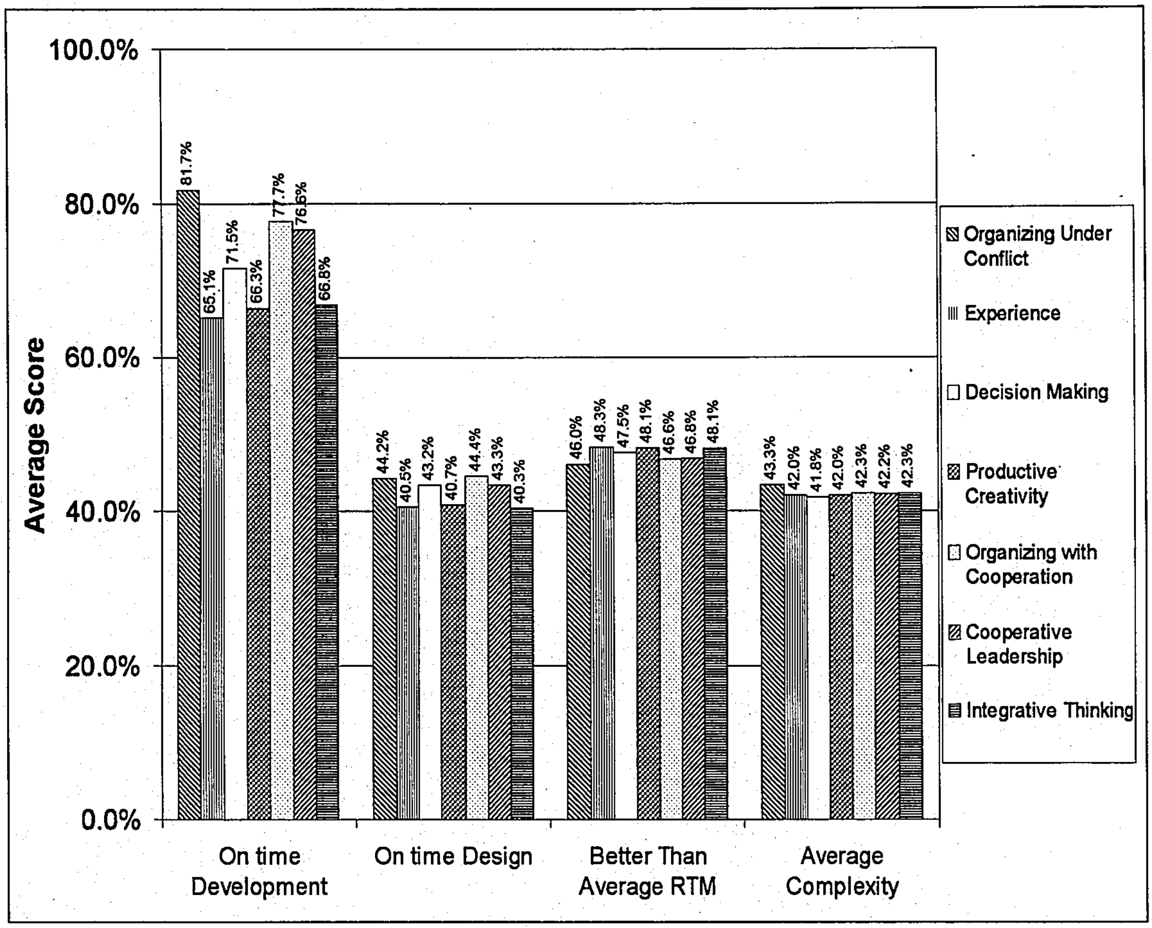
Factor	Average	Std. Dev.
Organizing Under Conflict	7.98	0.65
Experience	7.64	0.54
Decision Making	8.07	0.57
Productive Creativity	7.52	1.07
Organizing with Cooperation	7.75	0.48
Cooperative Leadership	7.40	0.54
Integrative Thinking	7.24	0.38

This analysis shows that these project managers rate themselves that best on those variables that related to decision making. The largest standard deviation occurs within productive creativity. This may indicate the largest variance in capability of project managers within these seven factors analyzed.

ANALYSIS

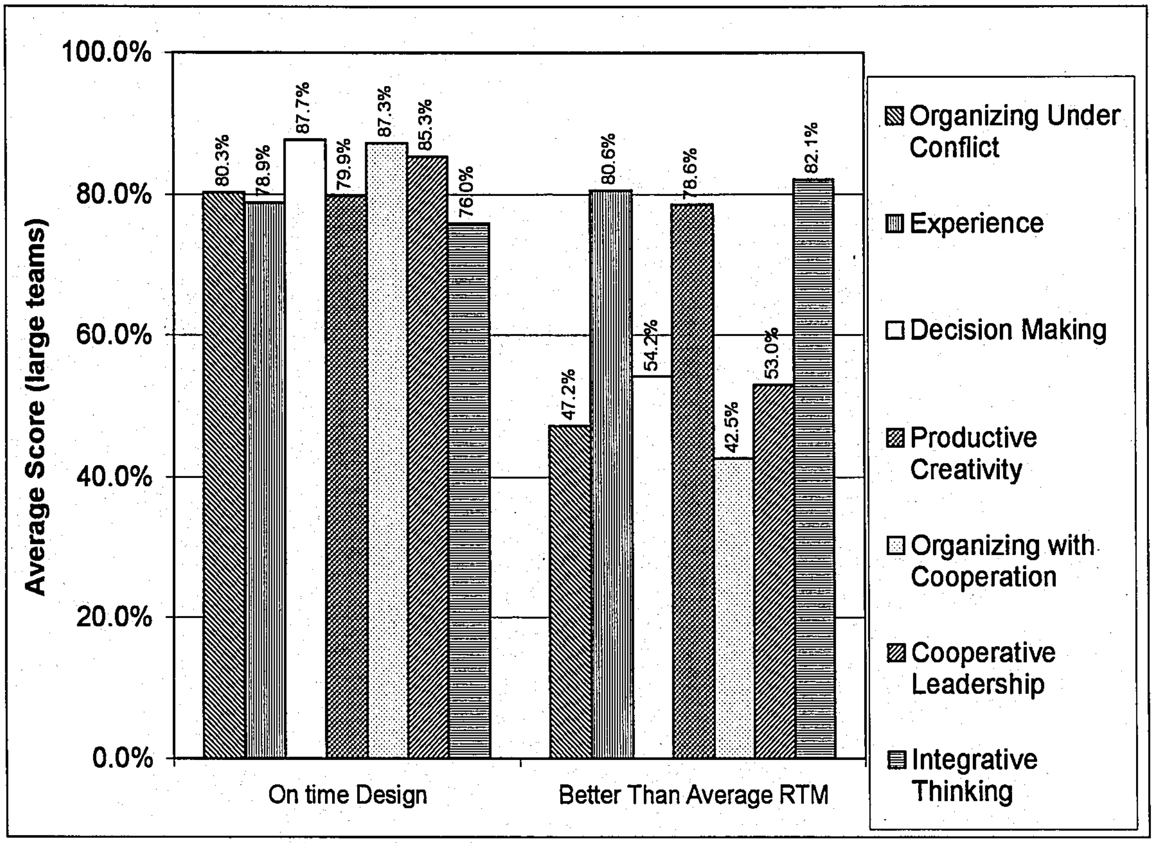
To analyze this data, we looked at the average scores for all factors under the conditions stated before. We then looked at these average scores with respect to the normal distribution of project management scores. For instance, in the average score for experience for project managers with on-time development projects was 7.64, this would be reported as 50% in Figure 5. If the average score for integrative thinking for project managers who managed on-time designs was 7.62 (the average score plus one standard deviation), this would be reported as 84.2%, following the distribution indicated by a normal distribution curve. Figure 5 shows the actual results of this analysis.

Figure 5 - Summary of Data



To further differentiate the on-time design and better than average RTM figures, we isolated those projects that had large amounts of people working on them (greater than 30). In total there were two projects exhibited both on time design and large teams, and two projects that exhibited better than average RTM and large teams. Figure 6 shows these results.

Figure 6 - Large Team Performance



DISCUSSION

As expected, those project managers that managed on on-time development projects exhibited higher scores in all factors identified. The average of these scores was significantly above the project manager average for all projects. There does seem to be a significantly higher level in the following factors: Organizing Under Conflict, Organizing with Cooperation, Cooperative Leadership, and Decision Making. What were not expected were the below average scores for on-time design, better than average RTM, and better than average complexity. In all three of these cases, no one particular factor is significantly higher or lower than the others. Furthermore, all of the average scores for these positive results where below the average for all projects.

The first possible explanation is that these factors listed are necessary, but not sufficient for on-time delivery projects. In other words, only project managers with exceptional scores in the factors listed can meet the criteria needed for on-time delivery. However, as seen with the other measures, it is not sufficient to have high scores in this area. In fact, other than "on-time development", the average scores for all factors is below the project manager average.

The second possible explanation is that project management in this organization is not a factor at all. More likely, there could be other influences with the Netcom SBU that do not allow project management to take the leadership role that it possesses in other firms. If this was the case, the measurements of the project management factors could be superfluous with respect to the actual outcome of the project. Given the fact that project management just started to become an established discipline within this organization just over three years ago, it might be that new product development processes are dominated by functional leaders in other organizations.

The third possible explanation is the problem with self-assessment. If it were the case that project managers could not evaluate themselves on a consistent basis, we could see these problems with scoring. The scores for on-time development, however, seem to refute this.

To expand this study and make it more relevant, I would suggest the following work.

1) Have someone other than the researcher collect the data on project managers from their superiors. This would eliminate the apprehension of some project managers to provide information to one of their peers. It would also be expected that the evaluations would be done on more of an even keel.
2) Expand the number of projects and project managers studied.
3) Include ratings of development leaders with the project managers to determine where the balance of power is within this organization.

However, some informative results do show up when looking at on-time design and better that average RTM time with respect to large teams. In the case of on-time design for large teams, we see similar results as with the on-time development. All factors appear to be necessary for those projects with large teams. With respect to RTM time, Experience, Productive Creativity, and Integrative Thinking appear to dominate. The variable that influence these factors the most are carrying through ideas, attending to others, and years of employment. The variables that affect these factors negatively are time management and planning/organizing. A quick glance at these factors seem to indicate that the RTM time is less about planning and more about doing.

Overall, the Netcom SBU should be looking for project managers that posses all of these factors. The research seems to indicate that those with the ability to organize under conflict, to organize with cooperation, and the ability to facilitate decisions can deliver projects on time with a higher likelihood. By looking a the specific variables involved in these factors, Netcom SBU management may want to consider the team management skills, the ability to delegate, and the willingness to learn as variables that greatly influence these factors the most. Furthermore, we identified as set of factors that were necessary for RTM time in large teams.

BIBLIOGRAPHY

Arlt, Robert, et-al., "The TADM Development Project: A Project Management Study", Delivered to Lehigh University Course GBUS 482 – R, D, and E Project Management, 1999.

Dinsmore, Paul C., Human Factors in Project Management, Rev ed. New York: AMACOM. 1990.

Griffen, Abbie, "Metrics for Measuring Product Cycle Time." Journal of Product Innovation Management 10 (1993): 112-125.

Hauser, John R., "Research, Development and Engineering Metrics." Management Science 44:12 (1998): 1670-1689.

Hauschildt, Juergen, et al., "Realistic criteria for project manager selection and development." Project Management Journal, Sep. 2000: 23-32.

Lucent Technologies, XPReS Phase Guide Rev. 2.1.3.

Meredith, Jack R. and Samuel J. Mantel, Jr., Project Management: A Managerial Approach. 3rd ed. New York: John Wiley & Sons, Inc. 1995.

Pinto, Jeffrey K. ed., The Project Management Institute Project Management Handbook. San Francisco: Jossey-Bass Publishers. 1998.

Roberts, Edward and Alan R. Fusfield, "Critical Functions: Needed Roles in the Innovation Process" The Human Side of Technological Innovation. Ed. Ralph Katz. New York: Oxford University Press, 1997. 273-287.

Roussel, Philip A., et al., Third Generation R&D: Managing the Link to Corporate Strategy. Boston: Harvard Business School Press. 1991.

APPENDICES

APPENDIX A – GLOSSARY OF TERMS

- ASIC – Application Specific Integrated Circuit
- DCF – Discounted Cash Flow
- IC – Integrated Circuit
- ME – Microelectronics group of Lucent Technologies
- Netcom SBU – Network Communications Strategic Business Unit. A unit under the IC Division of Agere Systems (formerly the Microelectronics Group of Lucent Technologies)
- Netlist – a description of an IC design
- NPV – Net Present Value
- PRTM – Pittiglio, Rabin, Todd & McGrath, a management consulting firm specializing in new product development.
- RTM – Ready to Manufacture
- XPReS – Cross-functional Product Realization System

APPENDIX B – HAUSCHLIDT'S FACTOR LOADINGS

Table 5 - Matrix of Loading Factors

Variable	Organizing Under Conflict	Experience	Decision Making	Productive Creativity	Organizing with Cooperation	Cooperative Leadership	Integrative Thinking
Critical Ability	0.76	-0.11	0.13	0.33		0.21	0.22
Time Management	0.76	-0.2	0.12		0.33		
Ability to Delegate	0.75	0.14	0.16		0.17	0.31	
Conflict Tolerance	0.7		0.18	0.23	0.26		0.23
Years of Employment	-0.13	0.88		0.17			
Knowledge Procedures	0.76			0.18		0.24	
Experience as a leader	0.15	0.66	0.24		0.2		
Experience in R&D		0.61				0.14	0.38
Holistic Thinking			0.83		0.14		0.2
Judgement	0.29	0.15	0.81			0.2	-0.15
Decision Making	0.29	0.33	0.58	0.38	0.25	-0.31	0.17
Shows Creativity		0.21		0.82		0.14	
Ideas and initiatives	0.19	0.17	0.14	0.73	0.24	0.18	-0.11
Carries Through Ideas	0.46	0.34	0.25	0.56	-0.27		0.29
Cost Management	0.19		0.32	0.43	0.22	-0.15	
Is Willing to Learn	0.27		0.18	0.12	0.73	0.19	
Plans and Organizes	0.53	0.15		-0.17	0.68		
Team Management	0.22		0.37	0.2	0.49	0.49	
Sensibility		0.2	0.16	0.28	0.46	0.29	0.43
Ability to Cooperate	0.2	0.23			0.13	0.79	0.19
Ability to Motivate	0.2	0.12	0.23	0.34	0.22	0.58	-0.26
Expresses Oneself Clearly	0.38	0.32	0.33		-0.19	0.55	0.34
Attends to Others	0.41	0.34		0.13	0.12		0.62
Systematic Thinking			0.5	0.15			0.84

VITA

Peter J. Stinson was born in Rahway, New Jersey on September 17, 1969 to Robert and Linda Stinson. He received a Bachelors of Science Degree in Computer Engineering from Lehigh University in June of 1991 and graduated with honors. He has worked for such distinguished companies as GEC-Marconi Avionics, Asea Brown Boveri, and is currently a project manager with Agere Systems (formerly the Microelectronics Group of Lucent Technologies). He has completed graduate courses in electrical engineering at Columbia University. His work in the protective relay industry led to a paper presentation at the Texas A&M Protective Relay Conference and US Patent No. 5,987,323: Method of Configuring a Microprocessor-based Relay for Use in Overcurrent Protection.

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