The Use of Virtual Teams in Technology-Driven Companies: Choices and Challenges

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Instructor: Dr. Dundar F. Kocaoglu

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Author(s): Ximena Barros, Blake Evenhus, Noda Huynh, Wendy Peterman, Jorge Torres, Jing Zhang (Group 4)

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Abstract

Virtual teams (VTs) are becoming an inevitable organizational structure for companies when working on high technology projects. The goal of this paper was to identify through literature research why companies choose to use VTs, what unique challenges a VT faces, and how VTs measure project success. Two case studies were identified and interviews were conducted with team members and leaders. The results were compared with the literature and conclusions were drawn. The interviews show that while both projects faced challenges because of being a VT, they were successful because of the VT structure. The main driving force for this success was the fact that the managers could pull employees in from all over the company and were not limited to employees who were co-located. This paper identifies what challenges the VT will face and how two real-life VTs overcame these challenges to be successful.

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I. INTRODUCTION

In light of the increasing decentralization and globalization of work processes, many organizations have responded to their dynamic environments by introducing virtual teams (VTs). Recent surveys and statistics show that the use of VTs has grown rapidly, with the support from new communication technologies such as the Internet [1]. The increasing popularity of VTs has spurred a growth in research examining various aspects of VT adoption and use. Over the last decade, researchers have sought to understand the benefits, costs, challenges, processes and outcomes associated with VTs and have given many findings. This project aims to verify the findings from literature by in-depth case studies of actual VTs.

To begin the study, the definition of VTs should be clarified. There has been a proliferation of its definition as the literature on VTs has grown. Martins, Gilson and Maynard give a review on the changing definitions, which can help us understand the concept better [2]. They point out that researchers are shifting away from defining a VT as a type of team that contrasts with a "traditional" or "conventional" face-to-face team but are focusing instead on "virtualness" as a potential characteristic of all teams. To date, the foundation for the majority of definitions is the notion that VTs are functioning teams that rely on technology-mediated communication while crossing several different boundaries. The most commonly noted boundaries are those of geography, time, and organization, with the first two being mentioned in almost all definitions. For this project, we adopt the definition of VTs as groups of geographically, organizationally and/or time dispersed workers brought together by information and telecommunication technologies to accomplish one or more organizational tasks [3].

Based on this definition, this project focuses on two aspects: (a) the reasons why companies choose to use VTs, and (b) the challenges that the companies face when using VTs. Our proposition is: VTs provide an alternate method to organize resources within a company but present a unique set of challenges which must be overcome to achieve project success. The project proceeds along two paths. On the one hand, we make a literature review and summarize the research findings. On the other hand, we select actual VTs as cases and have interviews with their leaders and members. The findings from literature and interviews are compared and combined as conclusions.

This project report is organized as follows: First, we provide a set of concepts based on the theory about VTs, focusing on the reasons, challenges and success factors. Second, we present the findings from interview cases with two VTs, focusing on the challenges and factors of success identified in these teams. Finally, we state the conclusions as a result of our analysis.

II. WHY CHOOSE VIRTUAL TEAMS

Companies use VTs when they perceive VTs will maximize performance. This is a common-sense view in line with literature. For example, Gupta points to VTs filling the need to be more competitive for global new product development [4]. The main sources of perceived performance maximization fall into three categories: personnel, productivity, and cost.

VTs can use the optimum personnel. VTs may draw in experts from any location [5, 6]. They also increase sensitivity to cultural issues by including members directly from cultures in question [6]. VTs give both organizations and their employees flexibility because team member workplace and work hours need not be fixed.

VTs may increase productivity in various ways. They save commuting time and travel time [5]. They also reduce the disruption in the life and work of the employee [7]. They may increase productivity since the employee can work in their "familiar environment" [5]. Global time differences allow the possibility of a 24-hour work day.

Cost reduction has aspects of labor, travel, and physical plant. Cost may be reduced by utilizing labor resources from cheaper locations. Virtual meetings do not have travel costs. However, travel costs are incurred when face-to-face meetings are required vs. a co-located team. Costs for "owning or leasing a building may be reduced and sometimes eliminated" [5].

The potential for using the very best personnel, increasing productivity, and reducing cost make VTs a natural choice for the competitive workplace, even though they present a unique set of challenges as outlined further in the next section.

III. CHALLENGES OF VIRTUAL TEAMS

A. *Communication Process*

1) *Definition of Effective Communication*: VTs have to deal with challenges related to the use of media rather than having face-to-face interactions among members. According to Yeatts and Hyten, effective communication processes result not only from encoding and transmitting a message through a medium but making sure that the receiver is able to understand and provide feedback about the message [8]. This process is particularly crucial when team members are spread out while working together on a project. In fact, effective communication among distributed team members seems to be related to both the social (refers to dynamics of personal relationships) as well as the technological or task dimensions (involves the efficiency of communication and exchange of information) [9].

2) *Challenges Associated with Communication Processes in Virtual Teams*: Sending information and gathering feedback are the two most significant challenges related to communication among VT members. The selection of the appropriate medium to transmit the information is what determines the successful transmission of the message

content. On the other hand, the feedback that usually comes from informal chats, facial expressions, body language, and other subtle signals when having face-to-face meetings have to be replaced by using direct messages and sometimes one-on-one conversations to clear up misunderstanding and overcome language and cultural barriers [10].

Both sending information and providing feedback are also influenced by the fact that, in VTs, team members tend to have different perspectives about the ways to deal with and solve a problem as a result of cultural and functional differences. Maloney and Zellmer-Bruhn argue that distributed teams need to develop "both social integration (a sense of cohesion […]) as well as self-verification (the process by which team members express their unique perspectives and receive acknowledgement […]) in order to reap the full benefits from heterogeneity" [11].

3) *Communication as a Key Factor to Share Understanding*: Communicating effectively in a VT is one of the key factors that lead to share understanding among team members. Sharing understanding means "having a base of shared experiences, having the opportunity to learn each other over time, communicating and sharing information, and developing a team spirit" [10]. Even though VT members do not share a common geographical context, they still can share experiences over time. In addition, sharing tasks, team and personal information gives them the opportunity to talk about and resolve problems while getting to know each other. The sense of spirit can be built when the team has an overriding goal in which team members believe. All these factors contribute to sharing understanding that leads the team to achieve the project's goals.

B. *Trust*

1) *Definition of Trust*: Nakayama, Binotto, and Smith have defined trust as "a disposition to diminish vulnerability in a team based on positive expectation as a result of mutual positive interactions" [9]. In VTs, the process of building trust implies the disposition to take risks, anticipate reciprocity, and set up expectations throughout time regarding the behavior of team members. In addition, factors such as knowledge and technical ability of team members, the practice of honesty and loyalty among team members, and the ability to receive compliments and criticism seem to facilitate trust in VTs. As a result, trust becomes a significant performance indicator that attest the amount of energy and time invested by each team member on the achievement of the project's goals [9].

2) *Challenges Associated with Trust Building*: The frequency and effectiveness of communication processes as well as the accomplishment of deliverables in a timely manner are very important conditions that need to be met in order to guarantee trust among VT members. "Lengthy intervals between communication, slow responses to teammates' questions, and failure to follow up on previous promises [10]" can result in mistrust. Therefore, responsiveness and dependability are the indicators of the team members' commitment and degree of contribution to the team.

3) *Strategies to Create Trust*: Robbins and Finley have proposed nine strategies for creating trust in VTs.

1. “Have clear, consistent goals
2. Be open, fair, and willing to listen
3. Be decisive- and how
4. Support all other team members
5. Take responsibility for team actions
6. Give credit to team members
7. Be sensitive to the needs of team members
8. Respect the opinions of others
9. Empower team members to act [12]”

In summary, trust is a belief that is hard to identify and develop. This is especially true for team members who are related in a virtual context that limits social interactions and psychological perceptions that are usually more feasible face-to-face. It appears that the more cultural differences, the more difficult become to establish trust among VT members [10]. However, in a virtual environment, trust still can be built when teammates are able to guarantee the delivery of their assigned portion of the work and maintain the focus on the final project’s goals.

C. *Use of Technology*

Technology is an important factor that determines VT communication. There are several kinds of communication technologies that are useful tools to help VTs have meetings and exchange information. Some of the most common tools are conferencing calls, video conference, and packages to maintain online meetings. Two of the most common packages to have online meetings are Live Meeting and Net Meeting. These packages will be discussed in this section to present the advantages and disadvantages as well.

“The most professional tool for virtual team meeting is On Demand Conferencing Services which enables your organization to leverage the individual features and functionalities of existing stand-alone investments, both hardware and applications, and integrate them into a truly unified communication solution” [13]. This integration simplifies conferencing and eliminates the need for end-users to schedule conferences, enabling organizations to realize the full potential of unified conferencing and collaboration.

The benefit of using this product is to integrate the individual features and functionalities of existing stand-alone investments, in hardware and applications, into a true unified communication solution. Also, it increases efficiency the assessment of corporate direction and requirements, plus best practice recommendations maximize efficiency in any communication environment.

Walk into any conference room, you'll find people relying on video products for communication and collaboration. Instead of flying executives all over the globe, corporations gain a first-mover advantage and save millions in travel expenses by deploying video conferencing. In addition, virtual global teams put video conferencing to work managing engineering projects. Video conference room solutions encompass a

range of offerings to meet the needs of any meeting room, from small offices to large boardrooms and auditoriums.

Therefore, the video conference room is also a necessary tool for VT meeting. The high definition video clarity is so real and the true-to-life people dimensions are so accurate that the far end participants appear to be just across the table. Extraordinary high definition video and audio in a telepresence setting, easily share high definition content during the video call with remote participants and complete interoperability with other video communications solutions. The eye-to-eye contact in a group setting is amazingly real, and the spatial audio causes heads to turn, almost unconsciously, to face the speaker.

The benefit of the video conference room is that productivity is increased because workers spend more time working and less time traveling. Business relationships develop and become more solid through continual, face-to-face communications. Sharing of ideas across distances is enhanced through content sharing and collaboration in conjunction with a real-life video presence. Limited financial and human resources that were spent on travel can be channeled into more productive efforts that will promote the value of the organization. Video communications has become an acceptable, productive means to connect with the dispersed team members and actually encourages more frequent collaboration. The quality of life for an organization's most valuable resource, its people, is preserved and results in greater employee retention.

Net Meeting provides an infrastructure for communication between network applications and services. In this infrastructure, Net Meeting is both an application and a platform for other applications or services. The components and services in Net Meeting provide real-time communication and collaboration over the Internet or an organization's intranet. Net Meeting allows users to have a much richer experience by sharing information on their PC with the people they are talking to.

Live Meeting is a hosted Web conferencing service that connects and engages audiences in online meetings and events through a reliable, enterprise-class hosted service. With meeting attendees participating from their PCs, you can deliver a presentation, kick off a project, brainstorm ideas, edit files, collaborate on whiteboards, and negotiate deals at a fraction of the cost and without the hassle of travel. The Live Meeting web conferencing service helps you and your employees run and participate in interactive meetings around the world with remote teams, prospects, customers, partners, colleagues and global audiences - in real time and at a moment's notice. With everyone participating from their desktops, teams can swap ideas, share information, mark up files, collaborate with whiteboards or negotiate deals - at a fraction of the cost of travel. Communicating with people more easily and quickly can help shorten sales cycles, increase productivity and improve the bottom line

The most convenient tool for VT is conference call. Conference calling is viewed as a primary means of cutting travel costs and allowing workers to be more productive by not

having to go out-of-office for meetings. However, people in the meeting cannot see each other.

D. *Leadership*

VTs introduce team leaders to a new set of unique challenges as previously mentioned in this paper. Because of this unique set of challenges team leaders face, a different style of management is required to be successful in leading a VT. As Kelley, Crossman, and Cannings [14] mention, "This new approach to team-working prompts questions about the management of virtual teams and the potential inadequacies of conventional management styles and techniques to deal with the problems, issues and challenges encountered by disaggregated and globally distributed individuals working in collaboration." The project lifecycle can be broken down into four stages, each of which requires a different set of tasks the leader must manage, these stages are: Pre-Project, Project Initiation, Mid Stream, and Wrap Up [15].

1) *Pre-Project*: The work that the team leader does prior to the project start is to lay the groundwork and creating a base from which to build the project. The project leader must establish a clear mission statement and a set of goals for the project. As Beranek, Broder, Reinig, Romano, and Sump [15] state, "If goal alignment is not formally established among team members, individuals tend to pursue different priorities and virtual projects often fail." A second task that is of extreme importance is choosing who is going to be on the team and clearly defining their roles. Since a project leader has an expanded network to choose from, they need to take the time to find the subject matter expert for each specific job. They must take into consideration that they should find someone who they think will fit into a VT given its specific set of challenges.

The final job of the team leader in this stage is to determine the technology requirements. Since the VT is going to require a unique set of tools to communicate and track the project, the team leader must establish the tools they think are going to be required and take the time to ensure each of the team members has access to these tools and is trained on how to use them. Each VT requires a unique set of technologies depending on the nature of the project. The team leader cannot assume that because VTs have been used in the company, or that some team members have been on a VT before, that the tools needed will automatically be available or training will not be required [15].

2) *Project Initiation*: The next stage is project initiation. This stage is defined as the time when the project team members have been given the project mission statement and are beginning to interact and work is starting on the project. The three main areas of focus for the leader at this stage are establishing trust, embracing diversity, and managing the work-cycle and meetings.

Trust is perhaps the most important aspect to manage for the VT leader because among all of the other factors it has the most potential to cause a breakdown in the team. Trust must be developed not only between team members but also between the team members

and the team leader. As Kelley, Crossman, and Cannings [14] state, "Managers of virtual teams have to find alternative strategies and tactics to compensate for the lack of planned and spontaneous face-to-face interactions in order to build mutual trust and reciprocal commitment." Trust must not only be established in the initiation stage but also strengthened and monitored through the entire project lifecycle once the groundwork has been laid at the beginning.

One way to help develop trust among team members is to invest in face-to-face meetings at project onset to help team members "put a name to a face" and to establish connections [16]. Another way to help maintain trust is to establish and use effectively the communication technologies that are available to the team leaders. VT members are judged based on actions rather than goodwill, so the use of technologies that actively show progress and items being completed by each team member will allow trust to build between members who know they can rely on each other to get the jobs done that they need [17].

Team leaders of VTs face a unique challenge in managing team members because often times the team leader has no real authority over their team members. As Oertig and Buergi [18] mention, "In order to influence people over whom they have no real authority, Project Leaders had to develop trust and respect, to enable them to successfully interact with each other and provide each other with what they need to develop the product." The VT leader must use effective communication in each of the stages to ensure team members they are competent to run the team.

The next area of focus in the project initiation stage is to embrace diversity and use it to enhance and improve the dynamics of the team. VTs are by nature made up of a diverse group of individuals from different parts of the country or even the globe. This diversity can affect trust and communication if not managed properly. The first way to combat is completed in the pre-project stage by choosing individuals who the project leader feels will accept diversity and not picking a team member who is notoriously hard to get along with or not accepting of diversity. As Beranek, Broder, Reinig, Romano, and Sump [15] state, "Virtual project leaders should anticipate non-shared group norms among diverse teams and weigh the costs of diversity against its benefits." Creating awareness of diversity and each team member's knowledge, skills, and abilities can reduce the effects of diversity and help build trust among team members [17]. Another way to combat the effects of culture/language is to work on establishing communication techniques that minimize the effects of the language barrier.

Managing the work-cycle and meetings is the final aspect of the Project Initiation stage that a leader needs to focus on. Establishing schedules for each aspect of the project down to as small of details as possible and using frequent report outs to clearly identify whether the project is on schedule will help keep the group task oriented and on schedule. Meetings are a good time for team members to communicate, but if not run effectively, meetings will become a waste of time and a distraction for team members. The project leader needs to establish from the onset what the meetings are going to look like and how they will be run, as Malhotra, Majchrzak, and Rosen [17] put it, "For a meeting to

capitalize on this opportunity, it must be managed carefully as a highly choreographed event." These meetings can include chunks of time that are set aside for informal discussion or brainstorming, but the agenda and time allotted to each task must be clearly defined and adhered to.

3) *Midstream*: The midstream stage of the project has two areas that leaders should focus on; these are progress/awareness, and visibility of the team within the organization. The leader must maintain focus on the overall goal of the project and ensure that each team member is aware of how the team is tracking towards that goal. Scorecards are a good way to keep track of the team's progress as well as having the project clearly defined and broken down into subtasks during the project initiation stage [17].

It is important for the manager to set up tools and resources for each team member to have awareness of the project. Awareness is "an understanding of the activities of others, which provides a context for your own activity" [15]. This awareness can be broken down into four types: awareness of project activities, awareness of the availability of team members, awareness of where each member's activities fit into the project, and awareness of the social aspects of each of the team members [15]. By building and maintaining these four types of awareness within the team, members will be able to stay on track towards their goals and trust between members will be built.

The next big task for the team leader in this stage is to maintain visibility of the team within the organization. Frequent report-outs to upper management and the online scorecards for the project can help maintain visibility [17]. If the project fades out of sight in the eyes of team members' direct managers, senior executives, stakeholders, etc. the focus for the team members may begin to fade because the virtual project will not be considered as much of a priority as some of the other projects the member may be working on because no one is asking questions about it outside the VT itself. Maintaining this visibility will also ensure that the VT receives all of the outside support it needs in a timely manner, such as funding, IT support, etc.

4) *Wrap Up*: The wrap-up stage of the project involves managing two main aspects, benefits for working on the team, as well as extracting lessons learned. Because team members are working outside the direct focus of their organization and manager, it is important that team members receive recognition for the jobs that they are doing. Recognition is an important motivation factor and can influence the willingness of each individual to work on future VTs. Kelley, Crossman, and Cannings [14] state, "The recognition events for the virtual team members tended to be less frequent than they had experienced in non-virtual-team-working. In all cases recognition for successful virtual team-working influenced willingness to participate in future virtual teams." Leaders need to understand this need for recognition and can have virtual reward ceremonies, pre-meeting recognition, and contact with team member's direct managers [17]. Team members should be willing to participate because, as Alexander [19] states, "Virtual teams hold out a promise that employees will be judged more on what they actually do than on what they appear to be doing."

The next part of the wrap-up stage is identifying lessons learned. The team should focus on identifying what worked and what did not as well as what could have been done differently to influence the success of the project. As Beranek, Broder, Reinig, Romano, and Sump [15] note, "We often observed that more can be learned from failure than can be learned from successes. Even though people are more willing to discuss successes, it is just as important to draw out mistakes and failures so that they are not likely repeated." The lessons learned exercise is also important to signal to each team member that the project is over so that any loose ends can be documented and assigned as needed and the rest of the team members can go back to their regular groups or to the next project.

IV. PROJECT SUCCESS FACTORS

The ultimate test of the team, virtual or otherwise, is whether or not the team's project is a success. The literature characterizes success in many ways. There is no one agreed-upon standard. The review of success literature in Kruglianskas and Moraes [20] finds two main points of view:

- Success in terms of the process and product
- Success with multiple, time-varying dimensions

Baccarini is an example of the success in terms of process and product view [21]. This author has a project management dimension for process success encompassing cost, time, quality and manner of execution [21]. The product factor includes meeting "strategic organizational objectives" as well as meeting customer and stakeholder needs [21]. Process success interacts with product success. This author perceives time as a factor in measuring success.

This study uses Shenhar's multi-dimensional success model because of its clear measures for success and because of its dependencies on both time and technological uncertainty [22]. The Shenhar [22] model has four factors for success, revealed from data analysis. The measures integral to each factor are shown in Table I. The factors are:

- Project efficiency
- Impact on the customer
- Direct business and organizational success
- Preparing for the future

Table I. Success Dimensions and Related Factors.
Source: Shenhar [22]

Success Dimension	**Measures**
Project Efficiency	Meeting schedule goal
	Meeting budget goal
Impact on the customer	Meeting functional performance
	Meeting technical specifications
	Fulfilling customer needs
	Solving customer's problem
	The customer is using the product
	Customer satisfaction
Business success	Commercial success
	Creating a large market share
Preparing for the future	Creating a new market
	Creating a new product line
	Developing a new technology

As in Baccarini, time affects the ability to measure success for Shenhar's model. Project efficiency can be measured even during the project. Clearly, impact on customer requires that the customer has had the product at least for a short while. "[A] significant level of sales" is needed to examine business success [22]. Preparing for the future requires the longest time frame, perhaps two to five or more years after project completion.

Logically, technological uncertainty changes the importance of each success dimension to the project. See Figure 1. As technological uncertainty goes up, factors whose effects need longer time lines become more important.

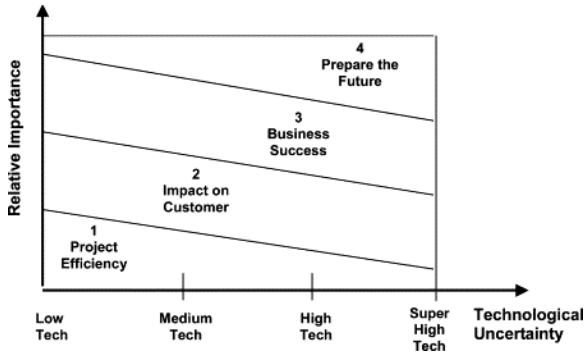

Figure 1. Technological Uncertainty vs.Relative Importance for Success Factors.
Source: Shenhar [22]

Our study looks at two high-technology cases. One is looking to specifically expand a market, the other to develop a new product line. Project efficiency is least important for high technology. That is, the company is likely to sacrifice cost and schedule for other factors. Preparation for the future is a factor, but not the main focus. Having "significantly improved capabilities" for customer impact and business success are most important per this model [22].

The cases are at different time stages. The Dell case just started implementing its service as of a month ago, and is continuing to add service regions according to a specified timeline. This means only project efficiency can be well defined at this point. The other case, Teradyne, has been on the market long enough to make determinations of project efficiency, impact on customer, and business success but not preparation for the future.

Since companies choose VTs to maximize performance, it is interesting to compare Shenhar's model with the elements companies use to choose a VT: personnel, productivity and cost. Clearly, productivity and cost relate to project efficiency. Project efficiency can be measured even as the task is underway. This seems to imply that companies have a short-term view when selecting the use of VTs. However, choosing VTs in order to have the right personnel relates to all of the factors for success in some way. Experts can do the project more efficiently. The right people can have insight to the customer and influence business success. Certain team members may be extremely creative and really help the project in preparing for the future. Looking at it this way, personnel choice is the most influential of the three for project success.

V. CASE STUDIES BACKGROUND

A. *DELL Inc.*

Dell was founded in 1984 by Michael Dell with only $1000 and one idea. Mr. Dell became the computer industry's most tenured CEO. He created a $12 billion company in just 13 years with a simple business insight: he could bypass the dealer channel through which personal computers were then being sold. Instead, he would sell directly to customers and build products to order. He implemented the *Direct Business Model*. This model eliminated retailers that added unnecessary time and cost or diminished Dell's understanding of customer expectations. Because of the direct customer approach Dell introduced technology in a faster way than others in the same business.

According to their global strategy which is being the premier provider of products and services Dell has launched sites and manufacturing facilities all over the world. Dell sites are in US, El Salvador, Brazil, India, China, England, and Ireland. Dell manufacturing facilities are in US, Europe, South America and Asia. This has given them a certain competitive advantage with their business competitors.

For this case we will analyze a Dell case study about their new service offered to native-Spanish speakers' population in the USA market. The reasons behind the creation of the project were fraud and complaints from the customers. An interview with Scott Kenyon (Sales Regional Manager for Dell Latin-America / Project Leader) helps us analyze their project from the VT point of view.

B. *Teradyne Inc.*

Teradyne was founded by Alex d'Arbeloff and Nick DeWolf, two classmates that met at MIT in the late 1940's. They pursued separate careers, getting together again in 1960 with the vision of starting their new own company. Alex and Nick foresaw that testing would become a bottleneck to high-volume production of electronic components unless the tasks performed by technicians and laboratory instruments could be automated. Their business plan involved of a new breed of "industrial grade" electronic test equipment, known as much for its reliability and economic payback as for its technical performance.

Teradyne continued its investment in R&D and has developed several new products in all its markets. In 2003, the company formally opened its Shanghai facility, where three product divisions-Semiconductor Test, Assembly Test and Connection Systems-are manufacturing, selling and supporting products for the growing Chinese electronics market. Teradyne's sold its Connection Systems business in late 2005. Today, Teradyne has two major business groups, Semiconductor Test, and the Systems Test Group (Assembly Test, Diagnostic Solutions and Broadband Test).

For this paper we will analyze Teradyne SB6G Automatic Test Equipment (ATE) project, a new product line for the high tech market, with interviews performed to Gary Ellmann (Senior Manager) and Ben Brown (Program Manager for the Product).

VI. CASE STUDY ANALYSIS

A. *Why Choose Virtual Teams*

Theory says companies perceive they will maximize performance using VTs, mainly through having the best personnel, more productivity, and less cost. In both the Dell and Teradyne cases, selecting optimum personnel is the primary reason for using a VT. Some, but not all, of the interviewees believe their VT is more productive. Cost saving perception is mixed as well.

Personnel who understand Spanish-speaking US culture are essential in the Dell project. Because of this, 25% of the team members speak Spanish. Even so, trying to get the best talent for the team is a challenge. These Spanish-speaking members are located in Central and South America. Despite being a global VT, no member is a Spanish-speaking US person.

The Dell project's ambitious goal, to include all marketing processes and products for US Spanish-speaking customers, necessitates cross-functional team representation. Besides

having Spanish-speaking representation, the team includes IT, telecommunications, learning and development, sales, operations, finance, and technical support members. Mr. Kenyon himself is the Dell leader because he demonstrates the capability to manage challenging projects with cross-cultural VTs. Leader and team represent all needed functions.

Including personnel for every needed function is the direct reason for Teradyne's VT. Both Mr. Ellmann and Mr. Brown believe that VTs allow experts to represent all disciplines on the team. Both state that face-to-face teams still need each necessary function, but end up using representatives for the skill set that may not be experts. The Teradyne co-located representative may not even have experience in the discipline at all. Mr. Ellmann feels that VTs are almost guaranteed today, because skills and people may be located anywhere.

Most, but not all, of the interviewees believe that the VT is more productive. Mr. Kenyon says that Dell is about 30% more efficient on his team because the personnel have high expertise. For Mr. Ellmann, completely representing all skill sets leads to the Teradyne's team on-time performance and technological success. In contrast, Mr. Brown believes the same VT requires much more integration time that would not otherwise be necessary. In both cases where productivity is seen as better, personnel are the cause.

As for cost, only Mr. Kenyon says the VT saves money. For Dell, Mr. Kenyon perceives the VT makes production less expensive. In his case, the team is international. Spanish-speaking country representation is a must. Given that the team needs to be global, a VT cuts down on travel.

Neither Mr. Brown nor Mr. Ellmann mention cost reduction as a VT benefit. This could be because, as Mr. Brown feels, there is substantial travel at the management level which would not otherwise occur. This suggests higher cost for the VT.

Overall, optimizing personnel for the team is essential for Dell and Teradyne; this leads to using VTs in both cases. All interviewees see getting the right members for the team as very important. Productivity is not viewed as higher for all cases. When productivity is viewed as improved, it is because of personnel. Cost savings are not clear. In the Dell case, travel would have been necessary so travel savings are realized. In the Teradyne case, travel costs were added that would not otherwise occur.

A. *Communication*

Effective communication is measured in terms of how well the message is transmitted by the sender and understood by the receiver. For that reason, we have analyzed how well the processes of sending information and gathering feedback occurred in both the Teradyne as well as the Dell VTs. Also, factors such as developing social relationships among team members and exchanging technical information regarding the project have been also taken into account to determine how cultural differences or teammates' roles

and functions have influenced in the effectiveness of communication processes. Table II presented below summarizes the concluding findings regarding communication processes in the VTs studied.

Table II: Communication Factors in Case Studies

COMMUNICATION FACTORS AND SUB-FACTORS	VTS STUDIED	
	TERADYNE **Automatic Test Equipment**	**DELL** **Service incremental innovation**
	Interviewee: Senior Manager and Project leader	**Interviewee: Sales Regional Manager for Latin America (Project leader)**
1. SENDING INFORMATION	The team leaders were responsible for exchanging information with other team leaders. The team leader communicated with team members of his/her own team	The project leader maintains frequent conference calls with teammates to send them information about the project
1.1 Sharing information	By using net meeting, all team members were able to see the messages that each team leader transmits to his/her teammates	Use of live meeting to allow all teammates participating from a particular meeting to see any information on the screen
1.2 Communication strategy	Direct and clear messages Maintain face-to-face meetings with team leaders No direct meetings with team members	Direct and clear messages No face-to-face meetings at all Conference calls with all team members
1.3 Communication shortfalls	Challenges related with clear understanding of expected individual outcomes occurred	Challenges related with language barriers (not all team members spoke English well) and poor quality of telecommunication channels used by the team were perceived as objectionable
2. RECEIVING FEEDBACK	The use of Net Meeting or phone to maintain updates regarding individual deliverables and project progress	Use of Live Meeting or conference calls to provide feedback about project progress to the project leader
2.1 Informal chats	The project leader traveled multiple times to meet the team leaders face-to-face and maintain conversations with them. This was a strategy to build relationship with the team leaders since some of them did not know each other prior the project	The project leader did not meet in person with any of his teammates because he knew each one before the actual project started. However, phone conversations helped to talk one-on-one with some of the teammates when needed
2.2 Influence of cultural differences	No cultural differences were perceived to be managed	Cultural differences were recognized and overcome by maintaining direct and clear communication related to expected individual deliverables
2.3 Influence of functional differences	Functional differences were acknowledged in team members. The functional differences were perceived as key factors for project success	Functional differences were preferred. These differences were perceived as key factors to guarantee project success after having a history of three prior similar projects that failed

According to the results presented, we conclude that effective communication processes in VTs are fundamental in order to attain integration in the team and keep team members focus on the achievement of the project's goals. The use of the appropriate technological platforms as well as the strategies to facilitate communication play an important role in terms of assuring effectiveness in the message transmission and reception. Even though social interactions at the informal level are more challenging when working in virtual environments, team leaders were able to develop strategic ways to establish relationships

with the team members. When cultural differences were identified, clear and direct communication was used in order to share understanding among all team members.

B. *Trust*

The following paragraph and information from Table III show the strategies and mechanisms used by the VTs studied in order to build trust.

Table III. Trust Factors in Case Studies

TRUST FACTORS	**VTS STUDIED**	
	TERADYNE **Automatic Test Equipment**	**DELL** **Service incremental innovation**
	Interviewee: Senior Manager and Project leader	**Interviewee: Sales Regional Manager for Latin America (Project leader)**
1. DEVELOPING TRUST		
1.1 Technical ability of team members	Team members were expected to figure out ways to solve problems on their own using their technical knowledge. The team leaders only intervened when things did not work out as planned. The team leaders followed up team members' parts of the work on a weekly basis, especially when problems needed to be fixed	Team members used their expertise to contribute to the project. If problems were encountered, the project leader requested additional support to solve technical issues. The project leader was in charge of making sure that technical problems were overcome
1.2 Honesty and loyalty	Clarity in the messages helped to communicate. Team members did not experience the pressure of blame when mistakes happened. Instead, participation was desired and encouraged	Clarity and directness were essential to facilitate communication. The most significant factor was loyalty, especially coming from the project leader. Team members knew that the project leader will provide full support and assistance regardless of possible mistakes or wrong decisions
1.3 Recognition and critics	Explicit recognition was offered to team members for outstanding individual performance. In addition, the overall team's results were recognized as successful when project started to produce tangible benefits for the company Critics were seen as a source of motivation to improve individual performance	Since the first results from the project launched were successful, the recognition was for the overall project rather than individually The project leader did not criticize team members when failures happened but stated clearly how he would like the mistakes to be corrected
1.4 Strategies to develop trust	Clear project goals helped team members understand what was expected from each member Participation was encouraged to solve technical challenges Individual recognition was practiced No blame rule when mistakes happened	Clear project goal helped project leader assign responsibilities to team members Team members were fully supported by the project leader Cultural differences were respected and manage properly by team leader Team members felt secure to express ideas and assume responsibility for their actions

Based on the VTs studied, we conclude that trust can be seen as a performance indicator of a project. Even though building trust in virtual environments is more challenging than when team members interact face-to-face, there are strategies that team leaders can carry

out in order to create trust. Factors such as avoiding punishment or blame when mistakes happen, delivering individual work as expected, recognizing individual achievements, sharing information openly and honestly, and being able to rely on teammates' technical skills are remarkable drivers for trust building.

C. *Technology*

Looking at the VTs chosen for our study, at Dell and Teradyne, the common communication tools are email, instant messenger and conference call. Net Meeting is used at Teradyne which allows all team members to see the exact same screen at the same time and bring up documentations and drawings. It can rotate control of screen, and it is extremely important to deal with document aspects. However, they cannot see other person in the meeting which sometimes turns out not to be effective.

Dell's VT used Live Meeting. All team members were able to see the same kind of information that was to be shared on the screen and provide feedback about what they were seeing. However, the capacity of this tool became a constraint for the communication process since it usually allows only up to seven different locations to be connected and sharing information effectively. In fact, the project manager mentioned that, in the future, he would like to acquire better telecommunication equipment.

Both these two companies could not use video conference due to limitations related to the network bandwidth of the companies themselves.

The benefit of Net Meeting and Live Meeting is lower cost and adjustable bandwidth for content. These systems will automatically adjust bandwidth allocation when sharing content based upon content being shown. The feature of user adjustable setting can be accessed both during a call and outside of a call. The beauty of these tools is the flexibility to choose the amount of bandwidth to dedicate to content or people, based upon what is being shown.

In conclusion, there is a variety of communication technologies that serve the companies according to their needs. In the case of Teradyne's VT, they used Net Meeting which helped the team to bring up documents and drawing to all exact same screens. On the other hand, Dell service innovation team used Live Meeting which allowed them to do a good job for storing data. As seen the selection of a particular technology tool should be done after a careful analysis of how the tool would contribute to help VTs achieve their project's goals. To accomplish that, VT leaders should explore all possible disadvantages and benefits of the existing communication technologies to choose the ones that could better contribute to facilitate the communication processes among team members of a project.

D. *Leadership*

1) *DELL, Scott Kenyon*: In the case of Scott Kenyon from Dell, Mr. Kenyon decided to only have meetings when required to allow team members to work and focus on product.

The selection of the team members was accomplished with good results because the use of the VT, but there was a lack of experience in the company when trying to sell to U.S. Spanish Speaking markets. Mr. Kenyon had to choose best members based on qualifications and how he felt they would perform on this project in a VT.

Some of the problems related to the project came from the leader himself in that he set-up the meetings in such a way that he had too many people on the conference calls. This presented some challenges. He could have broken the team up into smaller groups with focused meetings that would then choose a representative to coordinate with Mr. Kenyon and the other groups. Mr. Kenyon did state that directions from him did not always come across well to the team members. This could have been avoided in the Project Initiation stage by using face-to-face meetings to establish trust and build relationships between team members and the project leader.

Mr. Kenyon did make a good strategic decision by choosing to make the approach of the team very detail oriented, breaking the project down into details helped enable the team to not get slowed down by cultural differences. Mr. Kenyon's direction was to be very specific and direct. He also made the decision to work on the project simultaneously instead of waiting for one group to finish their portion of the work before starting on their own section. This can be hard for team members to do because of trust issues but having a leader give this kind of direction forced the team to have to trust that what the other team members were doing would be completed on time and as specified so that it would mesh with their portion of the project.

In order to reduce the impact of the project on individual team member's personal time, Mr. Kenyon, as the leader, scheduled meetings to meet the rest of the team's schedules. He forced himself into the office earlier than he would usually begin. This is important because it helped to build trust towards him from the team members. Mr. Kenyon also made it clear up front that he believed if a person was not making mistakes they were not working hard enough. He made it known from the onset of the project that mistakes were acceptable as long as person was trying hard and that he would protect the employees if they were to make a mistake. This allowed the team to take more risks and also helped build that trust in their leader. One weakness that Mr. Kenyon did recognize in his leadership style is that he does not always listen enough. He sometimes hears what he wants to hear and could have focused more on listening to his group.

2) *Teradyne, Gary Ellmann*: Mr. Ellmann stated that team member selection was a key to the success of the project. Taking the time up front to establish the right team with each discipline that will be required for success being represented enables project success. As a leader, Mr. Ellmann constantly traveled in order to ensure that the team was communicating and resolving any problems that occurred.

One thing that a project leader needs to focus on is ensuring that problems are clearly defined and not hidden way during a project. Another important aspect of the team leader is to ensure that problems are being resolved on the team. If they are not, the team leader needs to step in and ensure that problems would see a resolution. He would step in

if he perceived technical judgment issues existed and make sure each person would accept the others point-of-view, and that if a decision was made that both parties agreed the decision would be accepted and they would move on.

3) *Teradyne, Ben Brown:* One important factor that Mr. Brown focused on was that prior to the project launch, the team was picked so that every discipline required was represented and the best people to do the job were selected. Another important step that this project took was that Mr. Brown and the marketing representative clearly defined the mission statement of the project and the target specifications. The company would not allow the project to move forward until the objectives were down to two lines. Once the objectives were established, Mr. Brown made it clear to the team that if target specifications were exceeded, but it cost the team by creating a missed schedule, that was not acceptable. The schedule was more important as long as they were meeting the required specifications.

Another important step Mr. Brown set-up was to make the meetings a time to define problems, not to find solutions. The meeting time would be a time that the team would identify a problem as clearly and with as much detail as possible and then the team would identify who would be in charge of finding the solution and they would move on to the next problem. Each person or team that had been assigned to finding a solution was then expected to report back on Wednesday with the solution or if they needed help. This helped build trust in the group because each group knew it was alright to make mistakes or have problems and as long as they were willing to put them in the open and define them they would get the help they needed.

There was one leader in the group that was a poor leader and his team developed trust issues because of this. Mr. Brown had to replace this leader because it was hindering the project as well as his team. Recognition is a big part of leadership and in this project the customers began getting excited about the product as it was coming to a close and the project became something that was prestigious to be working on. Mr. Brown also had good sway in the company and was on the promotions board so when he recognized a team member for their efforts others accepted this.

The project had higher demand than most for leaders to maintain focus on goals and objectives of the project and there were constant report outs in the form of a formal review every two months. These report outs gave the team a good opportunity to focus on the issues and give themselves a reality check. The main sponsor of the project would not actually show up to the reviews, but other managers were invited so that the group could go through the exercise and maintain focus.

E. *Project Success Factors*

1) *DELL*: Dell's main goal in launching this project was to expand their market in the US, giving a more comfortable and secure purchase opportunity to Spanish speakers to buy a computer. Adopting the Shenhar model we observed the following:

- Project Efficiency was measured for Dell in terms of schedule goal; they had more pressure from the time to market than for the budget metric.
- Customer impact was measured on the solving problems stage; it was difficult to look for functional performance, meeting technical specifications or the customer usage of the product due to early launching (October 2007).
- Business success was measured from the market share increasing expectation that Mr. Kenyon told us, not real data due to the recent launching.
- Preparing for the future cannot be measured because the project was launched two months ago, but a subjective comment was done regarding new technology development.

Regarding Mr. Kenyon's interview, he mentioned that the main reason of success was the cross-functional high level of expertise team working for the project. As a result, the team was able to deliver a better solution in a faster time. These brought a cost reduction for the R&D process and a fast time-to-market service launch.

There's no data that confirm customer satisfaction/dissatisfaction with the new service; but this new project solved customer problems, providing them with more opportunities to buy a computer in a more secure way. Now customers were able now to buy computers in their native language and obtained the same financial services that are offered to US customers. For Dell this was a win - win situation because they increased their market share and customer satisfaction, giving what the customer really wants. This was reflected in a 5% market share goal increasing and having at least a 13% market share goal for next years.

This product prepared Dell for the future. The new software development opened opportunities in every Latin American market. Dell can apply the same techniques to improve its tools and expand markets in Europe, South America, and Central.

In summary, Dell, after 23 years in the market, understands that the best way to make a global project succeed is mixing different types of knowledge from different types of cultures, and without the best people on the team this project wouldn't have been as successful as it was. The Dell case matches perfectly with the Figure 1 analysis in which we observe that for a high tech company, meeting business success and customer impact are the two main factors.

2) *Teradyne*: Teradyne's main goal launching this project was to expand their market in the US and provide a testing parallel solution to their customers' new high technology product (PCI Express). Adopting Shenhar's model we observe the following:

- Project efficiency was measured in terms of meeting the schedule goal and staying in a budget.
- Customer impact was measured from meeting technical specifications and how this contributed to customer satisfaction and usage of the product.
- Business success was measured from the market share increasing and its profitability.
- Preparing for the future cannot be measured because of insufficiency of data.

In Teradyne's case, the main reason for success in project efficiency was the high tech experts. They delivered an improved and faster design cycle regardless of the technical difficulty that presented at the beginning. Also, a great level of organization was important to accomplish the schedule goal.

Looking at customer impact, Teradyne did well on technical specification and customer satisfaction measures. All technical specifications were accomplished due to the level of expertise of the team; Gary Ellmann mentioned that *"… the VT didn't make the project successful; it was the high tech level of the team that made it…"* The creation of the VT was because of the need of having the best people in the team to satisfy project expectations. Mr. Brown also said that Teradyne went beyond customer expectations with this new product, which incremented their customer satisfaction metric as well as their sales and profit margin for the tester.

In business success, Teradyne's SB6G was so popular, according to Mr. Brown, that their demand was higher than their supply. This produced a 20% price increase for the tester, therefore their profit margin also increased.

In summary, Teradyne launched a new type of high tech product to keep innovating, maintaining a demanding market and expanding it as well. The most important factor in success was creating a cross-functional team to meet project needs, which led to having a VT. The SB6G was launched on spring 2006; it doesn't give us the opportunity to deliver real time data from Teradyne according to the Shenhar model. However, Mr. Ellmann and Mr. Brown said that a door was open to get into a new market and to a new line of testers to supply their demand.

VII. CONCLUSION

VTs demand a unique set of managerial and leadership skills because of the unique challenges presented by the VT. Leaders can take steps to manage the issues surrounding the VTs and keep the team successful. During the initial stages of the project, the leader can focus on: establishing a clear mission/objective, choosing the right team members, ensuring the technology is available and ready for use by the team, building trust between members and embracing diversity among the team, setting up the project schedule into detailed tasks, and creating a meeting format that will ensure effective communication. As the project moves along and then concludes, the leader must focus on: project progress and awareness, visibility of the team within the organization, benefits of being on the team, and finally developing lessons learned for the project and closing it out.

From the interviews with Dell and Teradyne, the project leaders have a great influence on the overall success of the project and must manage team members in a different manner than in a typical co-located project. VT leaders must focus on managing the communication between team members and determine measures to identify if the project is on schedule and tasks are being completed. The overall consensus between both case studies was that the team members influence the success of the project more than any other aspect. The result of the VT structure is that managers can pull the best employees onto the team no matter where they are located and that is why both of these projects realized such great success.

A major challenge presented by these VTs is an effective coordination of efforts and ability to use available and new communication technology in ways that are clear and specific. The absence or reduced face-to-face communications contributes to these and other challenges. To become more effective and productive in the proper use of day to day technology communications etiquette among team members, we should minimize or eliminate conflicts that are prone to happen in organizations with lack of proper vision and training.

The communication process is one of the most challenging aspects when working in a VT. There are a number of limitations such as cultural differences, the use of appropriate channels to share information, and the difficulty of developing social relationships in virtual environments that can be overcome by the team leaders. In the case of Teradyne and Dell, the team leaders were able to develop appropriate strategies that encouraged team members to keep focused on the team's and the individual's achievements that determined project's successful results.

Building trust also plays an important role in the dynamics of VTs. Trust is seen as a performance indicator since it reflects the way team members manage their time and energy in order to accomplish the goals as well as another important challenge that managers have to face with. Based on the VTs of Dell and Teradyne, we conclude that trust has been created when team members communicated honestly and openly, delivered their portions of the work in a timely manner, were able to offer support to other team members, and solved problems without blaming each other.

In the cases studied, getting the right people for the job is the essential reason for forming a VT. The right people represent cross-functional and cross-cultural resources for Dell. For Teradyne, the right people represent all needed skill sets.

Where productivity is viewed as improved, personnel are the reason. Mr. Kenyon points to the high expertise of his team giving a 30% efficiency advantage. Mr. Ellmann views the full skill set as allowing the team to meet schedule. However, Mr. Brown believes VTs increase integration time.

Mr. Kenyon believes his team reduces cost; Mr. Brown believes the VT increases it. Dell's VT has less international travel than it would have for a face-to-face team. In contrast, Mr. Brown sees that managers must travel to meet with VT members. They would not travel for the face-to-face case.

Having different skills on a team and a different type of approach to the project from every individual was the main reason of success for both Teradyne SB6G and Dell SSS (Spanish Speakers Service) in the US VT projects. Increasing market share and profit margin were Dell and Teradyne short term wins.

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APPENDIX A: SCOTT KENYON INTERVIEW: DELL

INTERVIEW DONE WITH MR. SCOTT KENYON, SALES REGIONAL MANAGER OF DELL FOR LATINAMERICA

Project Description

The project was to improve sells in the U.S. market by creating a solution to serve Spanish-speaking customers. The objective was to put in Spanish all the marketing processes and products that Dell has available for its clients. These processes rank from attending phone call requests, maintenance requests, and all functions related to the selling and follow-up selling processes. In addition, the company wanted to offer financial solutions to facilitate the purchase of the company's products in the targeted market.

The goal was not only to "translate" the manuals and other materials for commercialization or phone calls done in Spanish with English-translated scripts, but to offer a radical innovative service for the 5% unattended market of Spanish-speaking customers.

The idea came up because of the multiple foreign companies that took advantage of Spanish-speakers in the U.S. because of the lack of policies to protect them as customers.

The project in Dell had failed three times in the last seven years. However, the Vice president of the company wanted to put Mr. Kenyon in charge of this project because of his multiple demonstrations of capability to manage challenging projects with cross-cultural VTs.
Kick off the project: January 2007
Project launched in October 26, 2007

How did they do it?
Marketing strategy
Vehicles (with advertising) + tv ads + radio campaigns + catalogs + newspaper ads
Goal
Launch service in one city every two months for the first 6 months. These cities were Houston, Atlanta, and Chicago.

Team members

- Location

The project involved various teams located in different geographic places such as El Salvador, Brazil, Panama, Ohio, Dallas, San Francisco, Tennessee, Nashville, Houston, and Austin.

- Team members' background

There were people coming from different departments such as IT, Telecommunications, Manufacturing, Learning and Development, Sales, Operations, Finance, and Technical Support.

The team members' experience in the company ranged between 6 months and 14 years of experience with one only exception of a team member (Hispanic) who had 4 or 5 years of previous experience but outside the company. He was in charge of the Marketing strategy.

75% of team members: Caucasian who do not speak Spanish.

25% of team members: speak Spanish, from Spanish-speaking countries of Central or South America.

CHALLENGES AND BENEFITS

Challenges

The effective use of resources (labor) to produce results in a timely manner. Graded with a 7.

The challenge was to bring the best talent of the company to work together using VTs. The idea was to have virtual meetings, and so on but ONLY when needed. Graded with a 7
Even though the selection of good team members, they did not have enough experience to sell in Spanish to U.S. Spanish-speaking customers.

Benefit

Increment sales in the U.S. market in a 5% (volume of Spanish-speaking customers). Graded with a 7

Communication

One of the team members in Brasil who is an IT employee had poor English skills.

Not good telecommunications. Conference calls with 15 people on the line were sometimes challenging. Directions from the project manager sometimes did not come across well.

Cultural Differences

There were not too many because team members have been in the company for a long time, most of them.

Since basic communication happened over the phone or via email, cultural differences were not perceived.

STRATEGIC APPROACH from the project manager: be “very” direct and detail-oriented.

Trust

The project manager gave specific instructions to teams to not wait until other team finishes his part of the work but to start working simultaneously so that everyone could meet the deadlines.

Technology use

Softwares used: Microsoft Project, Live Meeting. These programs helped to do a good job storing data.

Mostly used: Live Meeting. Positive aspect about this is that everyone can see (in the screen) the same thing. This helped to present the answers. Negative: Live Meeting can be used for up to 7 different locations.

For the future, the project manager would like to acquire better telecommunication equipment.

Time differences

A big challenge was to adjust to time. For instance, Brasil is 3 hours ahead compared to El Salvador. There was a 5 hour difference between all locations.

The plan was to do meetings around noon even though the project manager had to be at 6am at the office in order to do so.

The project manager was willing to do this because he did not want to hurt people’s live balance.

Leadership

STRATEGIC APPROACH from the project manager: to offer entire support to team members, even if they made a mistake so that they would feel protected. He would fight for his team members + be “very” direct and detail-oriented.

For the project manager, a mistake is a proof that one is working hard. Therefore, who does not make mistakes is not working hard enough. He actually said “Anything messed-up, I will cover it”.

One of the reasons why the past projects failed was because the former CEO did not allow mistakes to happen. Team members did not feel protected, and therefore, were not willing to take risks. The current project manager is willing to support and cover anyone in his team (who is part of the project) in order to ensure the achievement of the goal and build the trust.

One weakness that the project manager recognized as a leader was that he does not listen enough. He said "I get to heard what I want to heard".

PERFORMANCE

The main factor to achieve good performance: good team members. Graded with 7.

Results

Financial results are increments in sales and growth of the company in terms of both market share and profit.

Financing Spanish-speaking customers has been very successful. Dell has established a strategic alliance with 4 companies in order to offer financing solutions to the customers in the target market.

BUDGET

Michael Dell approved a certain budget (no specified by the interviewer) but the team didn't have to prove any ROI (Return on Investment) later on to senior staff.

Having this VT made the production process much faster as well as less expensive, they focused more in production than sales costs.

DEVELOPMENT CYCLE/TIME

There were no time considerations at the moment. But time saving was around 30% for the overall process due to the level of expertise of the people working on the VT.

INNOVATION

Basically, they start with a percentage of 90% incremental innovation [*he called this like normal innovation maybe something not that new, kind of an imitator]* and 10% radical innovation, which means that he said that they haven't been that innovative, but is one of their short term goals to increase that percentage. They have plans for moving forward TO this stage and to become more innovative. *[In terms of radical innovation, what he meant is that right now they were not innovating that much but they were planning to do so]*

The VT developed this software tools that were only in English, and did it for multiple languages (Portuguese, Spanish). A new tool with the same basics of the English one was created.

They have some software systems that they use to control sales activities, processes activities that are called IDD and SYMPHONY and they developed these tools for multiple languages, wasn't a translation of the US tool, and they had a plan for the next 18 months to develop a new strategy that will help them cover themselves against competitors (but obviously didn't want to say it).

MARKET EXPANSION

The Spanish market in the USA is around 5% but their main goal is to keep on growing 13% every year. And this metric will keep on growing because of the synergies that have created in their businesses, in which most of the processes now can be used in different countries; it’s much easier to readapt something than create it from zero.

APPENDIX B: GARY ELLMAN INTERVIEW: TERADYNE

NOTES FOR INTERVIEW WITH GARY ELLMANN NOV. 3, 2007

Background

SB6G Automatic Test Equipment (ATE) project at Teradyne, Inc.
Many local teams around US responsible for developing different parts of the products.

Mr. Ellmann is the San Jose senior manager for the team and communicates with other center's managers. He is located in San Jose. He is responsible for some hardware and software. 20 to 25 engineers report to him, not all on this project.

Other teams located in Fridley, MN; Boston, MA; Agoura Hills, CA; Tualatin, OR.
Mr. Ellmann is a member of a virtual management team.

Working groups of engineers had co-located teams and international teams with activities in India and US for 24 hour work day.

Why did Teradyne choose a VT?

Most important reason: to complete the team in terms of availability of people with needed skill sets.

VT is not ideal, not an objective in and of itself.

VTs are almost guaranteed because skills and people are all over the place and you draw resources as you need them. Having a skill set that makes you an effective member of a VT is a benefit to the individual.

Challenges (7 hardest, 1 easiest)

Building relationships-6: need to pay a lot of attention to this in face-to-face teams, too, but more so in VTs. Traveling is a very important part of a VT especially for the managers. Good relationships are important to insure successful communications.

Time zones-2: compromises your personal schedule. Not as important since his team mostly just in US.

Ability to share information-5: have technical solutions but must make sure deal with these aspects properly. All people need to have proper tools and be able to use them. His team was successful with computer tools and technology.

Difficulty in communication-6: Face-to-face can run into someone and solve a problem. Face-to-face interaction helps with the communication process. Some people are willing to contact others on phone and be clear about problem. Difficult for other people to

contact people by phone and be clear about problems. Always checking to make sure communication process is successful. Had a lot of regularly scheduled meetings. However, sometimes people were hard to get hold of when needed them. Takes more time to find people.

Getting the right people together, people who fit together well, people who can communicate by phone-5: They had a good set of people. If you do a good job of selecting the team, the team can work well together. May need to interview people for the team. May need to change team members if they don't work out. Started out with a few co-located team meetings.

He did have both people and technical issues on the project. Some issues would not have happened if people had been co-located. Such as misunderstandings in communication.

Benefits of a VT (7 most important, 1 least important)

Complete team, that is, have all functions represented-7: Necessary to have representation for all functions.

More formal communication-6: People put more emphasis on documentations, drawings, being prepared for a meeting. People have thought this through more. Ultimately, this is the right thing to do.

How successful was your project and why?

Successful: he defines as going through the design cycle in terms of meeting the schedule and technical success.

Mr. Ellmann felt it was pretty successful; he was impressed; technically difficult project that needed integration. The team met the technical plan they laid out.

Mr. Ellmann felt that it was hard to say that being a VT was cause of success. VT is established to ensure success by having a complete team; no compromises in availability of right resources to accomplish the project.

Schedule: Organization was very important. Part of the reason for success was they put a lot of emphasis on making a schedule. Schedule broke problem down into small pieces, allocated responsibility and gave them a handle on what to do.

Technology: Very successful in terms of technology. Met specification goals. Completeness of team brought about schedule and technology success. Team was complete because it was virtual. Virtualness of team was not what made it successful; completeness of team made it successful. Face-to-face teams which are not complete still do the work but allocate it to those who may be less competent.

Innovations, such as new patents: He felt there was no difference due to being in a VT. Mr. Ellmann felt that innovations really depend on individual and the manager of the team. Mr. Ellmann's team felt there was not that much brand new going on at the stage his team came onto the project. This was more at architectural design level with another team prior to formation of his VT. Mr. Ellmann's team was more focused on implementation.

What had the most impact on your performance as a VT?

*Ensuring successful communication***.** Technical problems quickly identified and resolved. People traveled when necessary. Some of the management team was traveling constantly. He thinks this is necessary in a VT. Want to do this if face-to-face or co-located, too.
Went well in this case, but Mr. Ellmann could see this could be a problem if things not communicated and solved in an effective way. Needs to be managed well.

Do people really understand each other? Need to keep probing on this or can have problems.
Mr. Ellmann made sure communication did not break down by constant meetings, multiple times per day by telephone, but may have been overdone. Over communicating better than under communicating. Certainly had situations where had communication breakdowns, but must expect that to some degree.

Building Trust

Trust was an issue. Trust is more complex and difficult with VTs. Since you aren't on site with each other don't have the opportunity to make friendships, necessarily. There was some amount of lack of trust that caused people to do second-guessing. Trust is multi-faceted:

- trust in technical judgement
- trust in motivations
- trust in intentions

How do you work out problems? Can call people or just let problems fester. If co-located more opportunity to say let's sit down and talk about this. If co-located, can pass person in hallway and work out problem and quickly resolve the problem. As a manager, Mr. Ellmann would, if he detected technical judgement issues between people, try to make sure people would at least accept the other person's point-of-view. When make decisions, he would make sure people would accept these decisions and move on. He would review the issues, see if need to communicate more, or need to accept decision and move on.

Technological Methods

Communicated by phone and net meeting.

Net meeting allows individuals to all see exact same screen, bringing up documentation and drawings, etc. Can rotate control of screen. Net meeting was extremely important. Net meeting dealt with the documentation aspects.

Meetings involve talking and showing documents. Phone and net meeting cover both of these.
Can't see other person, though. Tried to solve this with audio-visual meetings. This was not effective. The visual technology was not good. TV did not offer extra insight. Images were often frozen. Visual cues would be very beneficial.

APPENDIX C: BEN BROWN INTERVIEW: TERADYNE

Interviewers: Blake Evenhus and Noda Huynh
Interviewee: Ben Brown
Date: 11/04/07

Project Background:

Worked on SB6G Automatic Integrated Circuit Testing Equipment. 90 Engineers (Hardware, Software, Mechanical and Applications) and 10 Mfg Engineers, 1 Marketing.

Project lasted between two and two and a half years. Each engineering discipline had a leader that was in charge of that group.

Why project used a VT rather than a face-to-face team:

Resources were driving factor for using VT, had to go where people were located in order to assemble a team of experts and make sure all disciplines were represented.

Tualatin – 10-15 people
San Jose – 15 people
South California (Outside LA) – 15 people as well as the 10 Mfg engineers
Minnesota – 5 people
Boston – 10 people
Austin Texas – 1 person
North Carolina – Marketing person

Role in the team:

He was head of the project. He had led quite a few multi-site virtual projects, but this one was the largest project he had lead up to that point in terms of the number of sites.

Challenges:

Not everyone knew each other. Leaders were unfamiliar with each other.

Hardware and Software not always located together during point at which they were bringing up the system, including the application engineer. Linking hardware from two different sites provided some challenges.

Benefits:

VT allowed them to put together a team of experts. When building big project, often miss one group because no one is there at the time to support that function. Usually, non-VTs will just work on without that discipline but it comes back to hurt them in the end.

Communication:

In the start – The group conducted face to face meetings with leaders, frequent telephone meetings, Net Meeting and Conference Calls.

Mr. Brown traveled quite a bit. Leaders met four or five times as a group face to face. Mr. Brown traveled every other week to meet each site.

Leaders would meet and then bring information back to team. No need to meet with entire 100 person group. Unless subsystems did not mesh, at which time they would meet up at one site. Met on phone quite a bit, especially Net Meeting. Type in what was being talked about, clearly define problems right on screen. Everyone can see what is being typed in, can bring it down to the precise problem. People would come, state problem clearly and precisely, what needed to happen, what they can contribute, and who could help. People would then say what they could do to help solve the problem. Not having day to day run-ins, needed to have this clear communication. End of project people stated that it looked like the hardware and software was created by one person.

Spent a lot of time on meetings: 1.5 hours on Mondays with leaders on problems in general. 1 hour per week looking at schedule, 1 hour per week with each leader one on one. Lots of time on integration that wouldn't have otherwise been necessary.

Trust:

Trust was a big issue. Overcompensated for this by being precise with problem definitions and determining who was going to work each one out. In end, people stated they knew they could count on their team members, knew no one would ridicule or judge them for having problem, everyone would actually see what they could do to help.

One site without a strong leader did not have trust, thought their stuff was easy and segmented, not enough focus on group, when it got into trouble, people threw stones. Tried at first to let people figure it out on their own but then when that did not work the leader had to step in. Monday meetings, identified what problems were and who was going to take care of them. Meetings were not problem solving meetings, they

were just to discuss and define what the issues were and who would figure them out. Wednesday, the group expected email stating if it was solved or if they needed help.

Cultural Issues:

Cultural issues were not a big factor. This was not a multinational project, however it did span multiple areas of the country, but this did not have an affect on the group. One group had been purchased in acquisition and was not used to doing things in rigorous style, and had some bad blood from previous projects, so that aspect of the cultural differences had to be dealt with.

Benefits of having different cultures:

No benefit in this case, just one more hurdle to overcome. Other project that he has worked on this is a benefit, but this case it was not a factor.

How does the leader of a VT ensure that employees are maintaining focus on the project and working to ensure deadlines will be met?

This case, had some advantages, leadership team was put together at start of project. Marketing guy and Mr. Brown stated objectives clearly prior to moving forward. Company would not let the project proceed until the objectives were down to 2 lines. Simple, clear objectives. Specifications, time frame, etc. Engineers like to expand scope, not worry about time or cost. With all the upfront work on target specifications, made sure everyone knew objectives and the fact that even if you exceeded target spec by 1% but miss schedule it was not good. One person did not get onboard with this and wanted to go his own way but was eventually let go because of this. Have to be able to do this.

Recognition:

Leader knew what contributions were, personally had sway in company, was on promotions board. If he identified someone doing a good job, this was accepted by other people. Tight leadership team, knew project was going good, that helped in company to keep project in good light. Near end when customers were getting excited and reaction was positive, project became prestigious within company and it was a achievement to be on the project team. Far higher demand from leaders within the project to maintain focus on goals and objectives than other projects in the company.

Project Visibility:

Project got funding at start, did not get visibility as it went on because of another project. As project neared closer, customer got excited and put it on management's

radar. Helped in a way because group focused on schedule and scope and maintained management of themselves. Every project had to have formal review every two months. Boss of project would not actually show up, but the group went ahead and prepared for the review and gave it anyways. Review focused on issues and gave a good reality check.

Technology:

Technology tools: phone, email, share point web, WebEx Meeting, traveling for meeting.
Recommendations to use a specific tool: Email for argument is not a good thing. If he sees any argument email forward and backward many times, he will get up on the phone and stop those argument emails.
These tools are easy so that employees don't need to get trained.

Coordination and Time Differences:

The systems that your organization uses to coordinate the work that VTs are internal website and email.

Time difference is not an issue because it is just 3 hour different time zone. Employees come early or stay late.

Performance:

Measure performance in a VT with delivery schedule, cost, technical and price through customer's expectation.

Scale is 7 because the company needs smart people for this project.

Metrics performance for local teams is just schedule & cost because just one team and work for different companies. The most impact on a VT's performance is schedule.

Product is extremely successive because they achieve good design and technology. They could not have done that if they don't use VT.

Budget:

There is no improvement in the budget goals for a specific project because of the use of VTs. A VT contributes to reducing design extremely good.

Development / Cycle Time:

VT doesn't save time.

Innovation:

The manager knew this group can work on the project because of their knowledge. Changing industry, we could not have done it if not using VT. Nobody knew how to test this design.

Market Expansion:

The project needs people from different locations. Therefore, the VT helps the company growing the market expansion a lot.