The Future of Immersive Instructional Design for the Global Knowledge Economy: A Case Study of an IBM Project Management Training in Virtual Worlds

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ABSTRACT

Instructional design has not kept pace with the growth of the globalized knowledge economy. In the area of project management, a volatile global economy requires immersive learning and training exercises targeted to expert learners that have not yet been widely adopted. The authors developed a 16-hour, immersive collective learning experience for mid- to high-level project managers. The exercise was carried out in the Second Life Virtual Worlds platform and aimed to accelerate learning among participants. In addition, the authors tested a number of questions about the capacity of Virtual Worlds to be used for running complex, immersive learning and training. Results indicate that participants experienced high levels of engagement with exercise and, in the second iteration, were able to achieve goals within the exercise. Various technological breakdowns pointed to both the downsides as well as the opportunities for Virtual Worlds to be used for immersive rehearsal engagements.

Keywords: *Expertise, Immersive Learning, Instructional Design, Knowledge Economy, Project Management, Simulation, Virtual Worlds*

INTRODUCTION

IT implementation has been, and remains, one of the great enablers of the globalizing economy. IT systems such as Enterprise Resource Planning (ERP) or Supply Chain Management (SCM) pose increasing challenges commensurate with the complexity of global business; they are tools necessary or participating in a more complex business world, but also disruptive when not implemented well. One of the major issues we see in IT implementation failure is that the rapid growth of a globalized knowledge economy has outpaced the training and instructional design necessary to have a workforce adequately prepared to tackle new, complex challenges. Particularly for Project Managers (PMs) in IT, rapidly changing objectives, competitive

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environments and budgetary needs require a kind of adaptive flexibility that is difficult to guarantee with traditional training and professional development approaches. Project leads can easily lose sight of the uncertainty inherent in IT implementation, often underestimating the necessary time, money, and resources or even the real indicators of success that need to monitor, such as better outcomes for the business implementing the technology.

The experiences of effective project managers show that developing the needed adaptive flexibility among PMs of IT implementations at both the individual and organization level involves trial and error and learning through failure in complex situations. Yet, traditional classroom or workshop style instructional methods are not designed this way. Traditional methods often fail to sufficiently account for how people develop real expertise and tend to focus on specific steps, procedures, and skills instead of allowing learners to experience decision-making in an exploratory, outcomes-driven environment that helps develop higher-level skills such as agility and naturalistic decision making. Furthermore, traditional methods fail to sufficiently take advantage of emerging technologies that can enable a more immersive, exploratory learning experience to accelerate skills development among workers dealing with complex challenges.

In this paper we describe a 2-day exercise, called the Project Management Rehearsal Studio (PMRS), designed to provide an immersive learning experience for Project Managers at IBM using a Virtual Worlds technology. The exercise was designed to replicate a client engagement, and targeted complexities PMs face in a rapidly changing global knowledge economy. Specifically, it enabled users to practice the high level skills involved in IT implementation through iteratively rehearsing the implementation of enterprise business IT systems – in this case ERP. Furthermore, the experience targeted specific deficits in traditional instructional design methods among learners in complex, volatile environments. Lastly, virtual world technologies have allowed for a new generation of instructional design. Through this pilot project, we were able to reveal both the challenges and opportunities afforded by emerging virtual worlds' technologies.

Our goal for this paper is to illuminate key points of immersive simulation and rehearsal design that may be able to narrow the gulf between the kinds of skills required in the global knowledge economy and the instructional methods available to professionals in the field.

Literature Review

Project Management in the Globalized Knowledge Economy

Over the last half-century, massive global shifts from the industrial economy of the Fordist era to the globalized knowledge economy of the 21st century have transformed the way in which organizational knowledge is developed, trained, transferred and deployed. In the current environment, organizations face an increasing pressure to accelerate the speed of innovation. Competitive advantage is no longer measured by how much one produces, but by the degree to which individuals and companies are able to rapidly create and revise strategies to meet changing demands. As a result, learning in the knowledge economy is not measured by ability, but by *agility*. The complex problems that projects face today require Project Managers (PMs) working in this environment to go beyond declaring success when a project is completed on time, within budget, and within performance goals. Instead, PMs must develop a business-focused, success-oriented project approach that takes into consideration strategic and tactical aspects of project performance in both the short and long term.

One of the major remaining challenges of the current business environment has been successful IT implementation. IT implementation has been criticized over the years for being late in delivery, over budget, and lacking in adequate definition of objectives, all of which impact profit potential. For example, in 2003 only 34% of projects were considered successful, and 15%

were considered failures. Of the remaining 51% of projects that were considered "challenged", half of them had cost overruns of around 20%. And, of these "challenged" projects, time overruns had increased since the original reports to 82% percent (The Standish Report, 2003). The Standish Group also estimated that of the $382 billion spent in 2003 on IT projects in the U.S., $82 billion was a total waste. Moreover, one-third of the failed projects had cost overruns of 200 to 300 percent. In addition, of the more than 600 projects that Shenhar and Dvir (2007) studied over 15 years, 85 percent failed to meet time and budget goals, with an average overrun of 70 percent in time and 60 percent in budget.

In one study, Shenhar and Dvir (2007) used a diamond-shaped framework to analyze the successes and failures of the many projects they studied. The framework has four dimensions that distinguished the type of project being managed:

- Novelty—the uncertainty of the project's goal and/or market
- Technology—the level of technological uncertainty
- Complexity—the level of complexity of the product, task and project organization
- Pace—the urgency of the project

The authors found that in the unsuccessful projects they examined, there were often gaps between the projects required characteristics (based on the four dimensions of the diamond framework) and the actual management style that was used for the projects. This gap suggests that while the knowledge of requirements is in place, the development and training of PMs remains inadequate. A new approach is needed that focuses on managing projects for business results and not just on meeting time and budget goals.

While the skills required for PMs in the global knowledge economy have greatly shifted, instructional design techniques to accelerate learning to meet those demands have simply not kept pace.

Experts and Novices: Implications for Instructional Design

In part, the lack of adequate instructional design techniques is rooted in entrenched and at times outdated notions of how people learn. For decades researchers have repeatedly found the same key differences that have been shown to differentiate novices and experts, whatever the domain (Chi, Feltovich, & Glaser, 1981; Dreyfus & Dreyfus, 1986). The novice approaches problems with a formalized, literal understanding of problems, without contextual sensitivity. Even when they have a lot of classroom knowledge about a domain, novices do not understand, for example, how to react to anomalous situations and cannot articulate when it is appropriate to deviate from standard procedures (Dreyfus & Dreyfus, 1986). The expert, on the other hand, often after years, sometimes decades of experience with a particular task exhibits a conceptual, principled understanding of how to solve problems in a particular domain, regardless of the context. The expert can anticipate systematic errors and is able to make rapid judgments on an intuitive level, even sometimes in the face of conditions with which he or she has no direct practice or experience (Ericsson & Lehmann, 1996).

Other research has found differences in the task scenarios novices and experts use to most effectively scaffold learning. For example, novices learn well with tasks that have pre-programmed outcomes and rely on "worked examples" that provide procedural level understanding, wherein the solution to the problem is evident and the steps to achieve the solution are fixed. Experts, on the other hand, particularly those who routinely encounter dynamic, unpredictable environments, learn best with complex collaborative opportunities and exploratory learning methods in which they have room to design optimal strategies and sometimes even redefine intermediate goals.

For mid-to high-level PMs already working in complex task environments, worked examples trainings designed for novice learners could prove detrimental. In fact, in a phenomenon known as the *expertise reversal effect*, not only are "worked examples" training methods not helpful for experts, these methods can actually inhibit their development (Kalyuga, Ayres, Chandler, & Sweller, 2003).

Researchers have found that to achieve accelerated expertise development, one must target the ability to maintain effectiveness across contexts and situations (robustness), to recover quickly from outside disturbances that disrupt expected task flows (resilience), and to employ multiple pathways to a successful outcome (adaptivity) (Feltovich, Spiro, & Coulson, 1997). Instructional and training techniques that begin to address how train experts in the field, particularly those working in complex domains with high degrees of uncertainty, must be designed in such a way that at allow multiple opportunities to stretch current competencies along these domains.

Training for Cognitive Agility

Based on findings from this research and in light of new global economic realities, it is clear that methods that will drive learning among tomorrow's decision makers will target *agility* to handle volatile, changing environmental demands perhaps more so than simply the *ability* to achieve a particular level or set of skills. If one of the key ingredients of success in the new global economy is responding appropriately to change, then we must be training not only for the retention and transfer of skills related to execution and performance, but for a higher-level skill we call *cognitive agility*.

We have found that the development of expertise requires repeated encounters with highly challenging events in context, active problem solving, and embedded, immediate feedback on performance (DiBello, Missildine, & Struttman, 2009). Our field work with many organizations has revealed that the development of expertise at the individual level and at the organizational level occur through similar mechanisms, e.g., trying and failing, rehearsing approaches, seeing the results, refining the approach. Accelerating this developmental process requires intensive, immersive, repeated experience and practice to begin to addresses the training needs required for a new agile workforce. Many organizations simply do not have the time to wait for the world to present the right kinds of scenarios to build appropriate expertise, but they also do not have the approaches that can recreate these kinds of experiences to help advance employees to higher levels of expertise more quickly. Likewise, organizations that do not have much practice with major changes, such as IT implementations, act much as novices do, following recipes for action that may or not fit the situation. These circumstances very often lead to failure or less than expected results.

All of these insights lead to a similar conclusion: 1) Agility will be the key differentiating ingredient to the future success of individuals and organizations in a global economy, and 2) instructional design methods based on iterative, immersive rehearsal that allows for multiple iterations of failure and revision are best suited to address the future concerns of the growing global economy.

The Value of Immersive Simulation Methods

A growing consensus points to simulation based training (SBT), "Event-Based Approaches to Training" (EBAT), serious games, and immersive rehearsal methods as the most effective way to train for expertise in naturalistic settings (Fowlkes, 1998; Shubik, 2009; de Freitas, 2010). Simulation-based methods have been lauded for their ability to resolve several problems in training expertise in dynamic environments. First, simulation-based training allows for a participatory process, whereby expertise is not predetermined, but rather is allowed to emerge from situational constraints. In addition, simulation can provide a) a safe environment to practice making complex decisions in complex environments, with b) multiple practice opportunities, and c) opportunities for feedback that d) may highlight specific patterns among individuals or teams and e) can lead to the development of common goals (Cannon-Bowers & Bell, 1997; Klein, 1995; Oser, Cannon-Bowers, Dwyer, & Salas, 1997).

With immersive rehearsal methods, priority is often given to the outcomes and goals necessary for expert performance in a dynamic environment, rather than specific procedures by which decisions are reached, or specific instructions about how to carry out tasks. Participants are given the opportunity to reinvent the goals that need to be achieved based on changing environmental constraints, rather than learning the steps by which the goal is achieved. In addition, immersive methods allow participants to run through multiple iterations of a complex task, developing novel solutions to nuanced problems, rather than learning procedures by rote.

All of this research points to several key insights into effective methodologies for accelerated learning and the retention of proficiency (Hoffman, Feltovich, Fiore, Klein, & Andrews, 2009). Researchers have found that skill proficiency – even long after training – is less likely to degrade when the instructional method:

1. Is *immersive*, insofar as the training activates full, multiple sensory inputs for the learner, and the learning environment is richly structured and connected, rather than simply repeated and compartmentalized.
2. Involves *action-consequence* exercises with immediate, dynamic *feedback*.
3. Is easily *transferrable* from the learning context to application in the real world. The likelihood of carrying the benefits of safety training back to real work (skill transfer) is more likely when it is learned in the context of other skills that co-occur on the job.
4. Provides *understanding* rather than simple rote memory tasks.
5. Allows for *cognitive transformation* and *unlearning*. Learners must be able to examine what they know critically, and have the proper methods for "unlearning" misconceptions.
6. Provides opportunities to *iterative rehearsal*, insofar as learners must be able to develop strategies, make mistakes, and actively learn from mistakes in a trial and error manner.

While optimal strategies to accelerate learning and increase proficiency retention have been articulated, few methodologies have delivered sustained, reliable outcomes. Furthermore, measuring the true effectiveness of immersive simulation methods poses a number of difficulties (Ritterfeld et al., 2009). Many immersive simulations have qualitatively specific exercises tailored to specific tasks, which makes comparisons across techniques very difficult. Widely agreed upon metrics have not been developed. Results are often proprietary within the organizations under training. And, lastly, confounding factors and time pressures make controlled experiments in the field difficult, such that connecting skills in the training to results in the real becomes a huge obstacle to measuring effectiveness (Salas et al., 2009).

Technologies that (Might) Make it Happen: The Value of Immersive Virtual Worlds

Virtual Worlds are well suited for the kind of iterative, exploratory learning that will come to typify training and instructional design for workers handling complex assignments in a global economy (Thomas & Brown, 2011). Over the past 10 years, significant advances in immersive virtual technologies have altered the landscape of what is possible in training and education, strategic rehearsal, and organizational change (Crookall, 2010; de Freitas, et al., 2009). They provide immersive, virtual opportunities for rehearsal and training that allows participants to interact through avatars in an online virtual space, allowing them to accomplish tasks together by co-locating virtually from remote real world locations. As the web continues to grow and mature, a general shift toward bottom-up, user created collaboration tools with highly social capabilities in immersive environments will become increasingly normative (McKerlich, 2007).

A growing number of immersive Virtual Worlds like "OLIVE", OpenSim, "Protosphere" and MyCosm offer user hosted platforms, targeted more specifically for business training and collaboration or for immersive learning experiences for businesses, educators, military personnel and emergency responders. The potential business benefits of remote collaboration and time and travel costs savings of immersive simulation platforms is undeniable. We believe that beyond these obvious business benefits, Virtual Worlds afford a number of opportunities for enhanced accelerated learning, and the rehearsal and planning of complex strategies and tactical plans.

1. Learning and rehearsal in immersive, multi-player Virtual Worlds is more cost effective and scalable.
2. High risk exercises which cannot be practiced safely in real life are easily managed in virtual world sims with the same benefit as real life experience.
3. 3D virtual world training overcomes many of the cultural barriers that challenge employee training.
4. Mistakes are expensive. Virtual World allow high risk scenarios to be practiced without the cost of actual consequences.

Virtual Worlds have shown some initial successes in areas like education (Johnson et al.,1998), medical student assessment and treatment skills (Alverson et al., 2005), search and rescue operations (Lampton & Parsons, 2001), and Special Forces training (Raybourn, 2005). Emergency response personnel represents one of the largest areas in which trainings have been implemented in Virtual Worlds. These organizations conduct regular exercises to prepare for large-scale accidents (McGrath & Hill, 2004).

Despite vast opportunities and many initial successes, Virtual Worlds continue to have many drawback and limitations, including unfamiliar technology and interfaces, network maintenance issues, and avatar likeness and fidelity constraints (Berge, 2008). Other issues are also present from a design perspective. For example, facilitation and observation can pose new difficulties, as facilitators are often also play roles "in world," acting as both participant and observer. Furthermore, designers often fall back on old ways of thinking about training and instruction. As such, they too often simply migrate traditional instructional methods into Virtual Worlds, without exploiting the larger opportunities Virtual Worlds have to offer.

While numerous improvements still need to be made to make Virtual Worlds widely available to designers of immersive rehearsal exercises for large-scale training exercises, the technology affords a qualitative shift on three key features that are critical to learning but not easy to accomplish using other methods. Virtual Worlds 1) allow geographically distant team members to train and work together without the high cost of co-location, 2) enable "guided discovery" forms of learning that facilitate complex social interactions representative of real world tasks, and 3) provide immersive rehearsal opportunities with embedded, real-time feedback that facilitates the kind of trial and error learning methods necessary to enhance and accelerate learning among expert learners.

Hypotheses

The paper involves two primary lines of interrogation: 1) What instructional design methods are best suited to address the complex tasks faced by workers in the global knowledge economy, specifically Project Managers in large organizations? 2) What kinds of technologies are best suited to enhance the deployment of such methods?

Given the review above, it is our hypothesis that immersive simulation and rehearsal methods of instructional design are best suited to the new realities of the global knowledge economy. Furthermore, it is our view that Virtual Worlds represent the most promising technology to deliver the kind of complexity and granularity needed to adequately deploy immersive methods.

While the potential benefits of immersive methods are clear, many methodological questions about their effectiveness remain, some of which may never be resolved. For example, how do we develop metrics that can be applied across unique and often customized simulations? Without them, we cannot compare a method's effectiveness across domains. How do we place adequate controls on methods that rely on confounding, complex situations to isolate effective and ineffective factors?

Likewise, while the opportunities afforded by Virtual Worlds are clear, many questions remain. What applications are most appropriate for Virtual Worlds? How can the affordances of Virtual Worlds technology enhance and/or inhibit the effectiveness of immersive learning and training engagements? What unique forms of interaction do Virtual Worlds afford that must be taken into account by instructional designers working in Virtual Worlds? As with all emerging technologies, it will take a series of early adopters to test any number of applications before the value of Virtual Worlds becomes evident. The PMRS engagement acted as an ideal test of the capability of Virtual Worlds to deploy a complex, immersive rehearsal exercise among teams with existing expertise in a specific domain.

It is our aim in this paper to demonstrate how we designed an immersive simulation and rehearsal method to address skills necessary in a globalized economy, and how we navigated the use of Virtual Worlds to support this kind of skills development. We present the ways in which these methods showed success and the remaining challenges we continued to struggle with inherent in these emerging forms.

Methodology

Background of the Operational Simulation ("OpSim")

Before we outline the IBM Project Management Rehearsal Studio (PMRS) specifically, it is worth outlining the method, the "Operational Simulation" (OpSim) we used to design the exercise. The OpSim is an approach we developed 15 years ago, partially funded by NSF and NASA grants and has been deployed in a number of large organizations across a variety of industries, including bus maintenance, biotech, gold mining, medical device, and reinsurance. Every OpSim is unique, but it is designed with a set of meta-tools (the FutureView Suite) that create a specific, reality analogous business world or problem space. The PMRS is one application of the OpSim we designed specifically to target skills among project managers for IBM.

In an OpSim, participants must actually run a simulated organization with several interacting functions, attempting to meet or exceed their goals under a time pressure (e.g., often a "month" is 20 min in a manufacturing exercise). As part of the design of the OpSim, we conduct extensive semi-structured interviews with key organizational members using Cognitive Task Analysis techniques to determine the organizational blind spots and problems that are most inhibiting optimal performance. In addition, extensive research is done on the competitive space within which the organization competes to determine what an ideal performance in that space looks like. Lastly, analyses are conducted using our NSF funded Dynamic Strategic Modeling tool to determine the actual value that could be realized if the key identified problems were resolved. This allows us to set realistic goals within the immersive rehearsal while targeting the specific blind spots that are inhibiting the organization from reaching their potential. Once these initial factors are determined, we design the actual simulated tasks based on three key elements: 1) the non-negotiable goals (e.g., reduce backorder by 50%, increase revenues by $25M), 2) the opportunities to achieve those goals (e.g., penetrate a new market, explore new innovations), and 3) the constraints to achieving those goals (e.g., sovereign risk, regulatory requirements, operational bottlenecks).

While not all aspects of the real organizational environment are present, we design in the most relevant variables and tasks that allow them to work on achieving their goals. These tasks are supported by extensive data to drive decision making, technologies to support information sharing, and facilitators who play roles within the exercise (e.g., key suppliers, Chairman of the board, regional managers) to act as gatekeepers to success.

The structure of the OpSim involves a 2 iteration process. In other words, participants run through and attempt to reach the non-negotiable outcomes once. Then, regardless of their outcomes on the first iteration, the exercise is reset, and they run through the same process a second time. On the first iteration of the exercise (typically an 8-hour stretch) participants will invariably attempt to achieve goals using standard operating practices that will not work given the novel set of outcomes that have been engineered into the OpSim. As result, participants experience several cycles of failure and detailed feedback before they hit on a solution that will work. We believe this part of the process is actually an important "unlearning" of approaches that act as constraints to learning and changes in organizations. For example, when a major organizational breakdown is present in real life, the group often fails in a way that mirrors their current problems in the real workplace.

At any moment, participants can measure their performance against a hypothetical ideal in order to tell how far they are from the ideal on any of the parameters being measured during the exercise. Furthermore, the financial performance in the OpSim at the end of Iteration 1 often reflects what is happening in the actual organization. Despite continuous feedback, participants can often see that they are failing, but they often continue to repeat the mistakes they tend to make in real life.

During the second round of the exercise, Iteration 2, participants get an opportunity to start the exercise all over again. All of the mistakes and successes from the previous iteration are erased. At the start of the second round of the exercise, spreadsheets and graphical displays are provided that show the ideal versus the actual performance achieved (Figure 4). The participants discuss among themselves three issues: 1) what went wrong, 2) what they will do differently this time, and 3) how will they know it is working. During the second round, the participants must make their new plan work by running the OpSim again. They are under the same time pressure as before, with the same goals, running the same company, though some of the details of the external environment and the other materials are altered. As a result, participants cannot rely on memory of the details of the previous day to win the game, and must instead rely on an understanding of the underlying dynamic relationships among relevant variables. After having "default" approaches to the problems fail in the first Iteration, participants begin innovating and rehearsing novel solutions to novel goals.

The ultimate goal of the OpSim method is to help challenge the existing mental models participants use to approach problems by providing a platform of new leading goals and activities to help reorganize entrenched behavioral patterns. Although we are not always able to measure the success of an OpSim with similar real-world gains in the client company, (mainly due to the complexity of the factors involved in a client's performance, especially very large clients, and an inability to apply standard experimental control groups in naturalistic settings), in some cases organizations have applied almost the exact solutions they developed within the OpSim itself to resolve the problems they were having in the real world. Business benefits extending from the application of solutions derived in the OpSim represent a highly desired form of transferability. Furthermore, the time compression allows participants to implicitly learn the underlying dynamical higher-order relationships among key variables that would normally be difficult to discern when the time frame is stretched over many months as it is in the real world.

Essential to the success of the OpSim is reorganizing participants' "default mental models" – or "business as usual" approaches to solving a problem – to meet the demands of the goals that have been designed into the environment. To achieve this kind of cognitive reorganization, however, the default mental model must first be "activated" and "decomposed" before they are able to envision new solutions. Participants confront organizational failures and rehearse strategic solutions while being held accountable to non-negotiable outcomes (for more case studies, see DiBello & Missildine, 2008; DiBello, Missildine, & Struttman, 2009). As their existing mental models are weakened they become open to new ways to solve familiar problems in novel contexts with dynamic outcomes.

The Project Management Rehearsal Studio (PMRS) OpSim: Theory, Methodology and Implementation

In 2007-8 we designed and conducted a 2-iteration, 16-hour immersive rehearsal OpSim exercise in Second Life with mid- to high-level IBM project managers. Named the Project Management Rehearsal Studio (PMRS) it was developed to provide a *collective* learning experience for intact implementation engagement teams, whose members have a range of skills and varying levels of prior experience in project management—but who have not yet (at least as a group) made the shift to perform at the highest level of consultative practice. In the PMRS, real IBM project managers work together in Second Life as a team to implement a new supply chain IT system for a fictitious client, Lynchpin Industries, an auto parts supplier that, in the fictional scenario, hires IBM to help them improve their financial performance. Lynchpin was modeled after an actual autoparts supplier while many of the IT challenges were modeled after challenges that regularly threaten IT implementation projects, such as change in management or ownership, a strategy change within the client company, or poor project scoping.

Building out the landscape in the Second Life Virtual Worlds platform, we designed the major functional areas and associated physical locations to support the decision making necessary to meet the goals of the exercise (Figures 3 through 8). These areas, along with encounters with facilitators who played various key roles in the exercise, provided the immersive artifacts necessary to fill out an adequate exploratory learning environment.

The Project Management Rehearsal Studio (PMRS) OpSim was developed to provide a *collective* learning experience for intact customer engagement teams, whose members have a range of skills and varying levels of prior experience in project management—but who have not yet (at least as a group) made the shift to perform at the highest level of consultative practice. As per our usual design process of an OpSim we began by using Cognitive Task Analysis (CTA) techniques to elicit and define how expert level project manager's ideally approach their everyday tasks. Through extensive interviews, CTA and shadowing with high-level IBM project managers, a common expert project management mental model began to emerge and we began to uncover the key blind spots that typically lead to failure among PMs. Results from this research showed that, overwhelmingly, very high performing project managers organized their work around three primary goals:

1. *Value to the client's business:* Was the project contributing to the success of the client's strategy for success?
2. *Stakeholder engagement:* Did the project manager have access to the right stakeholders and were they in tune with and satisfied with the progress of the project?
3. *Value to IBM:* Was the project profitable, strategically important (entering new markets) and were resources deployed for maximum benefit?

Novice and Expert Mental Models: Shifting from "Execute the Plan" to "Make the Client Successful"

Keeping these three goals in balance and learning to recognize opportunities that would maximize each, led these managers to innovative solutions, even when a project was problematic or when a scope change was required. In other words, the primary model expert PMs

Figure 1. Chart showing revenue and costs Iteration 1

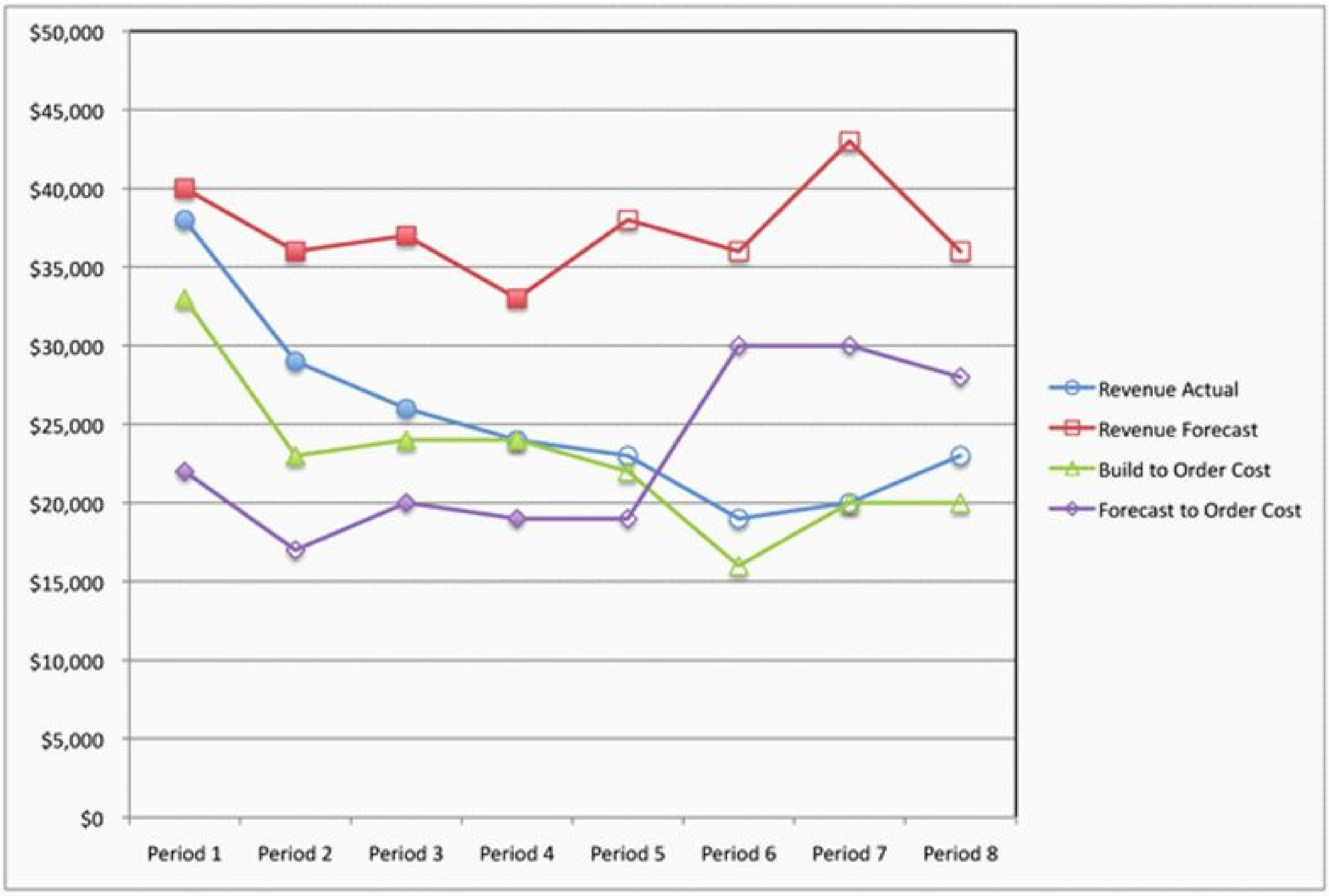


Figure 2. Chart showing revenue and costs Iteration 2

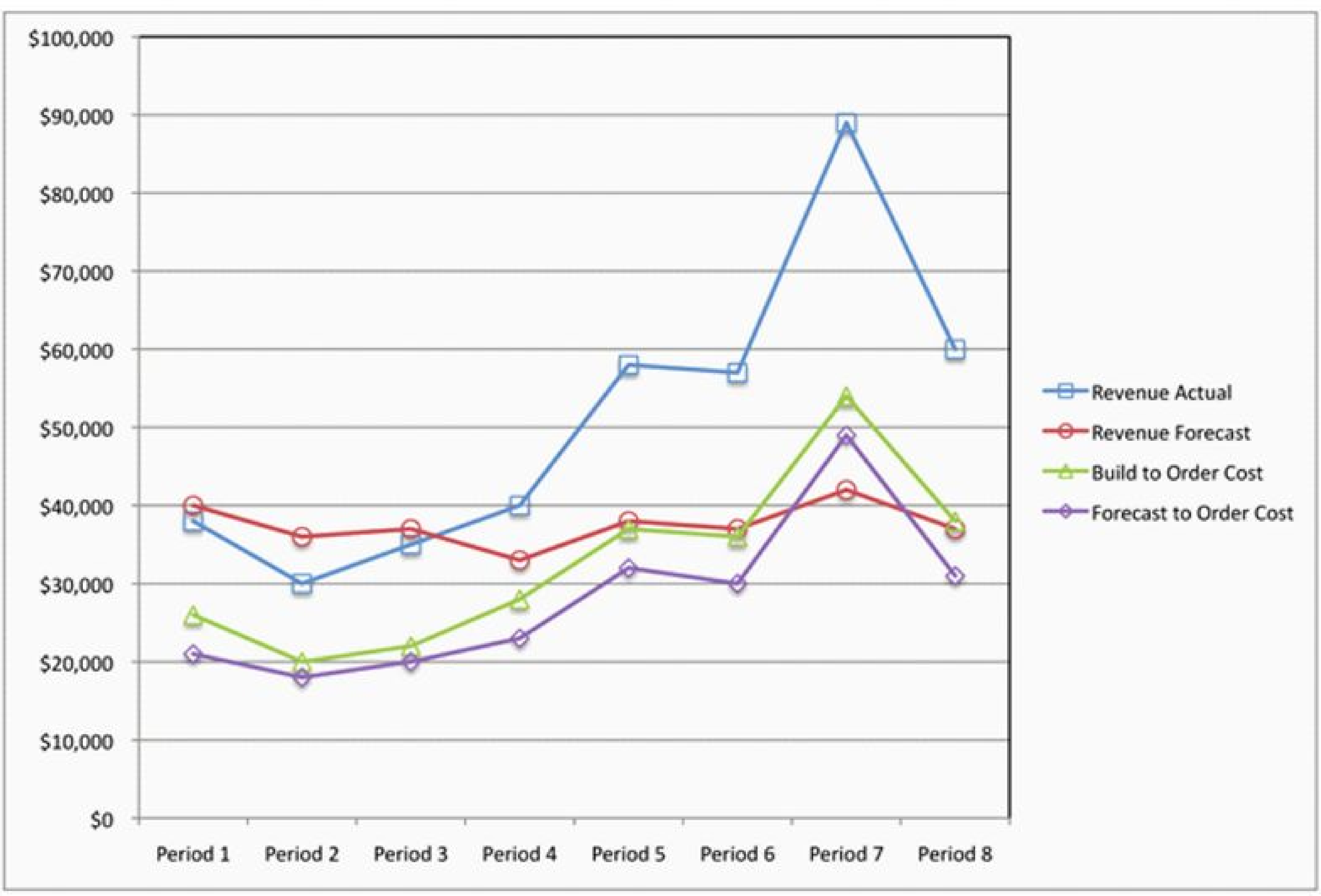


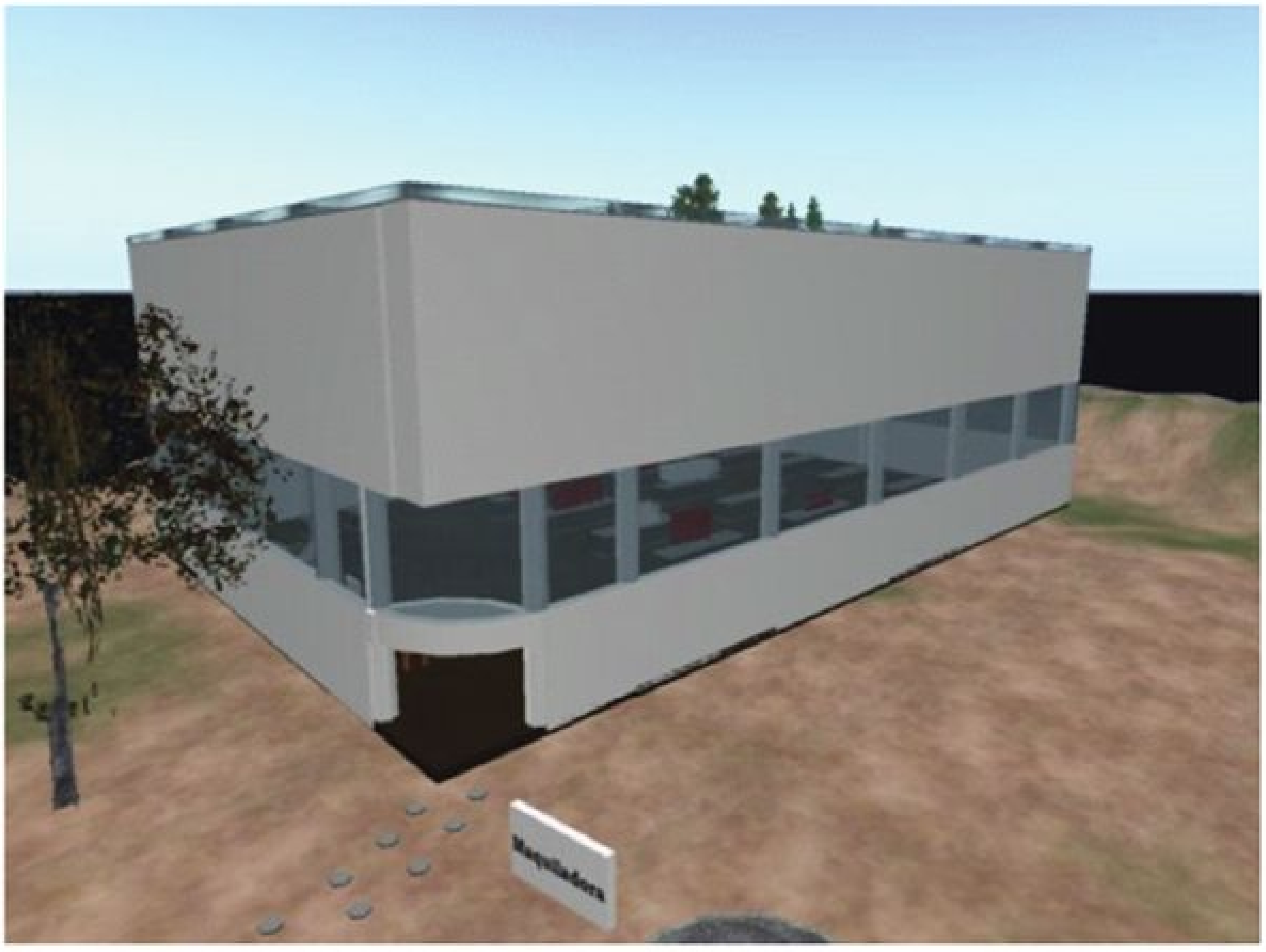
Figure 3. Major functional areas of the exercise, including headquarters, team rooms, distribution centers, an assembly plant and the Seven Keys assessment area

Figure 4. Team meeting room with charts to evaluate revenue goals and revise changes to the plan

used when approaching new assignments was to "make the client successful," while gaining adequate access to key stakeholders and adding value to IBM. In contrast, we found that novice PMs approach new assignments with the implicit mental model "execute the plan." Novice PMs are often more focused on a detailed execution of the original proposal. Often the original proposal requires a number of modifications, such as scope changes, as complexities of the project unfold. Novice PMs are likely to miss opportunities to make the client successful and generate revenue for IBM, because they are more likely to adhere to the original specifications of what was sold to the client. However, making the client successful requires changing strategy as changing environmental realities force changes in scope, budget, strategy and goals. As such, the PMRS was designed to reflect a typical, immersive PM engagement that required multiple revisions in the proposal by the PM teams.

Our primary objective was to design the engagement in such a way that "making the

Figure 5. Assembly center. The assembly center (located in "Mexico" represented a significant opportunity to meet customer's revenue goals



client successful," while gaining access to key stakeholders and adding value to IBM was the only way to "win" the engagement. In this way, we promote an expert mental model, without precisely defining its parameters. At the same time, if participants relied on a novice approach to the engagement, they could not be successful as simply "executing the plan" was not enough to achieve requisite outcomes. Participants were forced to rethink the existing implementation plan, re-scope the project, win over stakeholder support and implement a new ERP system. In doing so, we allow the novice mental model to fail, compelling the development of a more "expert" like understanding of the problem and formulation of a solution.

Results

What Happened in the PMRS?

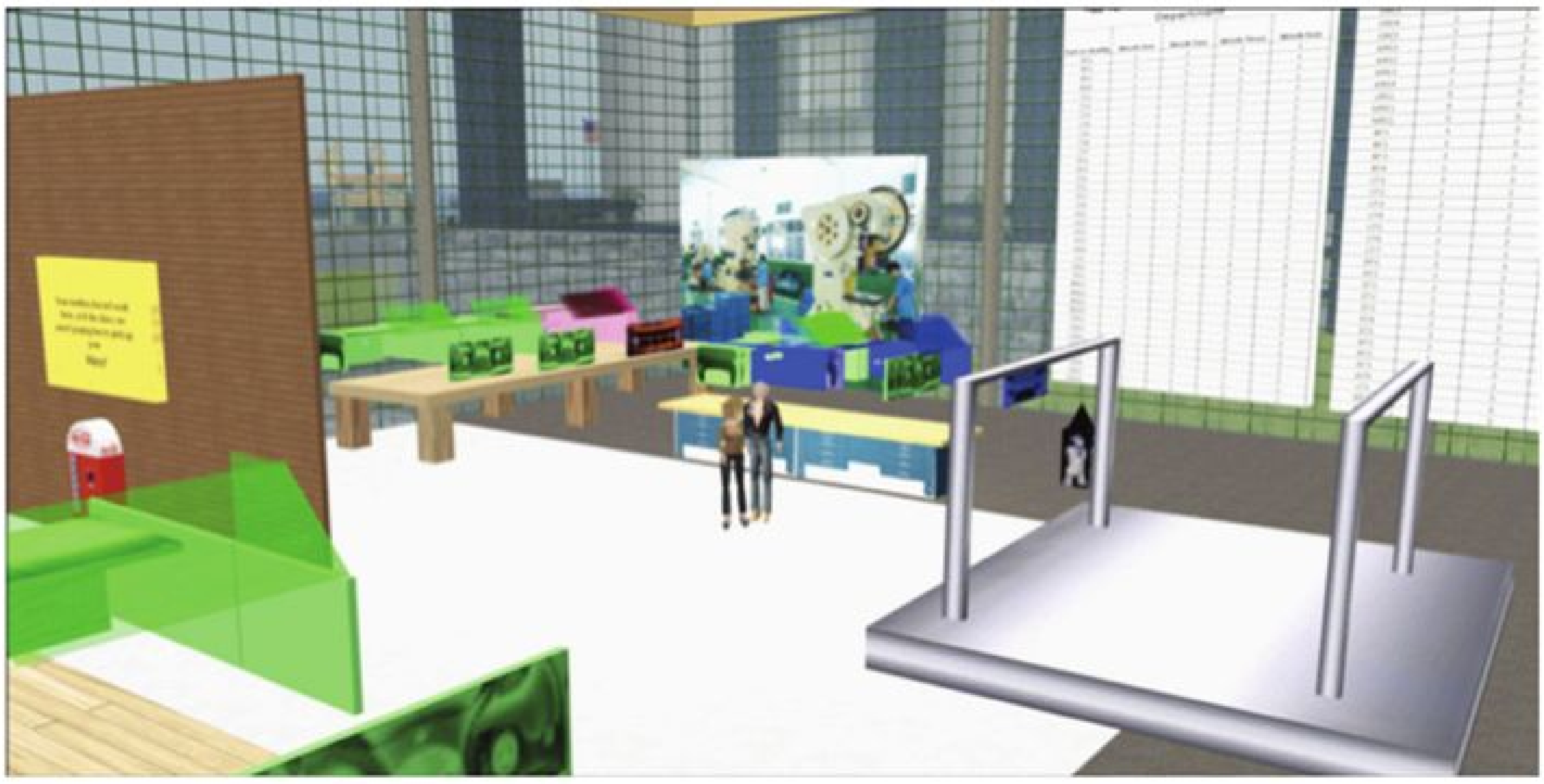
The PMRS occurred over 8 days, 2 hours each day. The first 8 hours (4 days) represented Iteration 1; the second 8 hours represented Iteration 2. Each hour represented a month of real time in which the project was unfolding and deadlines were set. Iteration 1 represented 8 months of real time. In Iteration 2, participants were able to run through the "8 month" implementation project again.

25 participants worked as a team with the goal of achieving better results for a fictitious client, Lynchpin Industries. Lynchpin Industries is an auto parts supplier that has hired IBM project managers to help them develop and implement strategic goals that improve company performance. At a high level, the participants' job is to implement a new ERP system, help influence strategy and to manage client expectations using IBM's processes, methods and tools. At the beginning of the exercise, the current CEO (with whom IBM sales conducted all their negotiations) retires, and the new CEO of Lynchpin, launches a new business development plan, which is a radical departure from the approach IBM was prepared for. His proposal includes revenue goals but does not offer great insight into how the operations need to be organized to meet his goals. He expects IBM to implement all of the IT and ERP design and infrastructure that will support his goals.

Figure 6. Lynchpin corporate headquarters. Here participants would make presentations to the CEO to lobby for scope changes, obtain signoff on new plans, and present project progress

Figure 7. Distribution center. Participants could make site visits and talk to distribution center managers to better understand issues in the field. They would take this information back to the team and rework ERP plans in accordance with project goals. After an ERP plan is loaded into a web-portal by the team, the make and buy reports appear "in world" in the appropriate facilities. Robots read the reports and bill of materials and follow the plan. Each "bench" creates a different part or assembly. As they are "shipped" to fill purchase orders, they disappear from the shelves and the revenue is tracked for the sale. Missing inventory results in a backorder that is filled when the part becomes available

Figure 8. Distribution center



However, this means that the original proposal as sold, scope, and partnerships with the client are no longer relevant. Thus, the participant's primary task is to develop a solution that meets the new CEOs vision for revenue goals by re-envisioning what's possible for the client, rather than simply implementing what was in the original contract.

At a high level, the exercise compelled participants to develop a new, detailed project plan with timeline and deliverables, negotiate scope and budget concerns, uncover deeply flawed supply chain issues, and adapt quickly to changing management structures and changing market forces. Participants also needed to organize an efficient division of labor among the team, conduct extensive meetings with the new CEO and planning manager, meet with suppliers and conduct site visits to major entities in the PMRS, such as the distribution centers and assembly plants, and come up with a new timeline and deliverables, with a goal to design ERP reports so that each center in the supply chain knows what to ship to whom and when. This had to be done in such a way as to eliminate as many steps in the process as possible, which was critical to the CEO's revenue goals. The business objective of the exercise was for the participants to propose a way of using ERP so that the Sales Forecast is used to drive parts orders in the most efficient way and with the least duplicate steps. In order for Lynchpin to succeed with its plan to deliver assemblies to body shops, demand had to be calculated at various points. Participants had to determine the setbacks for assemblies and design the reports for each facility that is part of the Lynchpin supply chain. Ideally, the participants will include the suppliers in this process. Participants were held accountable to concrete, non-negotiable outcomes.

The PMRS is organized into periods. Each Period lasts one-half hour, and represents a month of "real time" for Lynchpin Industries. During each Period, new customer orders will come in and must be fulfilled, while the team is also conducting site visits, negotiating scope changes and gaining stakeholder support. Core deliverables include a project plan, statement of work (SoW), project change request (PCR), and conditions of satisfaction (CoS) card.

The exercise is populated by various constraints and opportunities that are scripted into the environment and into roles played by the facilitators. If taken advantage of, these opportunities can turn into incredible returns for the client, the ultimate goal for the IBM project managers. The participant team can develop the project in a direction for maximum benefit to the client by recognizing and pursuing these opportunities: 1) scope expansion that adds value to IBM and the client's business, 2) novel innovation solutions to client's strategic problems, 3) increased trust and access to senior management resulting in greater stakeholder commitment, and 4) on time or early completion of the project. However, there is also built in risk to these situations. If not handled right, these events could result in negative consequences, including: 1) uncompensated scope creep, 2) rework, 3) project delays, 4) project completed over budget, and 5) stakeholder disengagement.

Facilitator Roles

Facilitators play the roles of various Lynchpin employees and their suppliers, for example, the airbag Supplier (LeCusion Inc.) the CEO, and the Lynchpin executive assistant. When playing these roles, they follow the appropriate facilitator "script" of behaviors in the storyboard for the first part of the exercise, but they must dynamically respond to changing concerns of participants. Thus, while facilitators have a basic outline of how to respond to participant actions, they must be able to adapt to evolving concerns of participants. They must be able to inhabit roles as though they were actually a client, CEO, or Supplier. Certain parameters are put in place to guide their decisions. For example, the participant team must devise a plan for the customer that meets some basic financial requirements or the CEO will not sign off on the proposal. Another example is that that the participants have an opportunity to restructure the parts ordering process. However, they must go through certain channels and ask the right questions for that opportunity to present itself. Increasingly (and by design) the participants take over the project and Lynchpin employee/facilitators primarily respond to the proposals, plans and reports that the participants give them.

Overview of Results of the PMRS

As mentioned earlier, we do not measure "success" of the exercise by whether or not the achievements made in the OpSim are evident by real numbers in the real world, although we have often seen real world improvements in the organization that were made based on solutions derived in the exercise (DiBello & Missildine, 2008). Instead, we measure participants' success by: 1) their ability to meet the non-negotiable outcomes within the exercise. We design the exercise such that meeting these goals (which are often revenue or output-based) indicates that 2) they have shifted, at least at the team level, to a new mental model in line with a higher level of expertise relative to the task, and that 3) they have applied the new mental model to achieve outcomes within the exercise. As mentioned earlier, by adhering to their default mental model, in this case "execute the plan," they would not be successful. By adopting the target mental model, "make the client successful," they can achieve requisite outcomes.

Results: Iteration 1

In line with our hypotheses regarding iterative learning, no team successfully implemented ERP the first time through the exercise. On the first time through, they adhered to their default mental models as indicated by several key behaviors:

1. Slow to realize the old plan was inadequate
2. Slow to do site visits – spent a lot of time in team room
3. Did not initially realize key opportunities – i.e., assembly plant in Mexico
4. Obtained signoff on new plan very late
5. Began to turn around end of the day

Interestingly, they tended to fall into the same pitfalls that plague ERP engagements in general. The team was able to track their progress and the impact of their plan on the company. They could see the month-by-month metrics revealing inconsistent results that failed to meet the ideal outcomes. The manufactured parts, assemblies, shipped items, and costs for running the operation were automatically tracked and the financial impact of the supply chain plan could be automatically monitored as the team's plan was deployed. As can be seen (Figures 1 and 2 - purple line) gross revenue goals and lower costs (pink line) were not achieved with the first plan. After the votes were made, we could compare how the facilitators, including the fictitious CEO, perceived the performance of the team versus the team's own perception of its performance. By the end of Iteration 1, the team's perception of its own performance was higher than that of the facilitators, indicating an overconfidence in a mental model that was not adequately meeting the target outcomes.

Results: Iteration 2

By the end of Iteration 2, the team was able to achieve success for the client. They did so by immediately recognizing the need to scope changes and interrogating flaws in the original plan. They were able to develop a complex ERP deployment plan that delivered the desired benefits with no disruptions to the operations. Below one can see that in Iteration 2, participants showed a marked improvement when contrasted with the mistakes made in Iteration 1.

1. Realized early that scope change was necessary
2. Spent little time in team room, immediately gathered data from sites
3. Scrapped old proposal and obtained signoff on new one
4. Reorganized parts ordering process
5. Opened new operations at the Maquiladora
6. Implemented new plan
7. Outcomes of the plan realized by the end of Iteration 2

These behaviors led the team to meet and then exceed target revenue and cost goals (Figures 1 and 2). As one can see in these charts, in the second Iteration the team was able to stay within budgeted costs while exceeding revenue targets. Another important shift took place that engineered as an opportunity into the OpSim.

Their superior results occurred based on several key insights and decisions made by the team. First, the team realized that they could achieve lower costs and deliver higher revenues by moving from a "build to order" (BTO) model to a "forecast to order" (FTO) model. Lynchpin, the fictitious auto parts supply client, began with a BTO model, in which parts would be made based on the current orders coming in for the month. The PMs in the OpSim were able to convince and obtain signoff for the client to move to a FTO model, whereby parts could be ordered in three-month increments, introducing a greater degree of predictability into the process and ultimately lowering costs by reorganizing the ERP system.

Second, the team was able to work with the client to reorganize the ERP system by streamlining the parts ordering process between the two distribution centers, and by exploiting an opportunity to work with an assembly plant in Mexico. By doing so, they were able to cut costs and create a more predictable ordering forecast. However, this strategy required several steps: 1) extensive interaction during site visits with employees in the client's company (these roles were played by facilitators), 2) consensus among team members that a rewriting of the original proposal was necessary to meet the client's goals, which included a scope change, 3) obtaining signoff from the CEO, and 4) implementing the new plan and overseeing the execution of the project until it produced revenue outcomes in line with expectations.

Qualitative Results of the PMRS: Follow Up Assessment

After the PMRS concluded, we asked the participants to give detailed feedback on their experiences. We asked them to indicate what was valuable about the exercise for them and what didn't work or could be improved. In general, the participants felt engaged with the task and found it useful along several key dimensions relevant for Project Managers. However, they indicated a number of difficulties with the Virtual World itself and some took issue with the types of activities that were engineered into the actual design.

Stepping it Up, Direct Interaction, and Greater Agility

Participants indicated that the exercise helped them "step up" their responsibilities and experience new tasks, it pushed them to seek contact and get a feel for what's really going on in the field, and it helped develop a sense of flexibility and promoted teamwork. One participant said: "The simulation enables participants to "step up" and take on additional responsibilities with less risk. High performers in real life can take on more leadership roles." Another indicated that the PMRS helped him understand the need to be in more direct contact with clients: "It helped me to identify my strength of speaking directly w/ clients to obtain better direction and status of the project. I realized that many consultants do not like to interact directly w/ the client and would prefer to work autonomously. I will strive to make this a necessary part of my future roles." Another participant indicated that the "[PMRS] honed skills such as acting quickly and flexibly to changing requirements, team management and organization, and teamwork and communication." This statement points to the way in which the PMRS was able to target agility among participants.

Technical Breakdowns

While the participants showed adequate engagement in the task, motivation to produce outcomes, and demonstrated learning in the areas of responsibility, agility, and communication, the Virtual Worlds technology itself produced a number of glitches, some of which were in our control and others that were artifacts of the technology. The primary issue was network failures. If a network becomes unresponsive or the Virtual World itself experiences bandwidth issues or general problems functioning, the result is that an avatar is often logged off. This means that in the middle of a team meeting, with time pressure always a factor, one or more avatars might suddenly disappear, get relocated, or "freeze." This requires a minute or two for the participant to re-login. This occurred several times to a number of different participants and proved to be a significant source of frustration.

An important piece of this, however, is that participants, particularly in Iteration 2, often turned these glitches into opportunities for the team. One project lead writes: "My approach in Iteration 1 was to follow the sim's lead and use their proposed team structure on the assumption that it was correct. On Iteration 2, I used the contract to break down work into the two or three objectives that I wanted to achieve. Then I double assigned resources to objectives to mitigate against people dropping off the Sim or having communication issues. After the major objectives were set, I used the remaining people to look at softer objectives (like process improvement recommendations), and to focus on suspected issues that were not in the contract (like Change Management)." The fact the people were getting kicked offline by network errors meant they weren't able to fulfill certain roles. As a result, the project lead created redundancy in the resources to make the sure the objectives were met, leading him to rework the team structure.

Proximal Concerns

One participant writes of significant communication challenges due to too much noise and people being arbitrarily "relocated". This relocation was an effect of the glitches in the Second Life platform – avatars would get kicked off and when they logged in again, would reappear in a different location: "The technology never got transparent - communication was a constant challenge. Also, you couldn't have two conversations in proximity (e.g., at HQ [corporate headquarters]) without a lot of noise pollution, so meetings were delayed while people relocated in arbitrary directions. I eventually started flying straight up in the air to get to a quiet place to talk to people." Because you could hear conversations from distances longer than would be audible in real life, in the beginning, people would stand in normal proximity and would have a lot of "noise pollution."

This, perhaps, was a downside in the design – we didn't anticipate the degree to which people would tend to reproduce talking distances typical of real life. However, as can be seen in this quote, participants often found ways to use the affordances of the technology to resolve the issue. In this case, flying high up in the air to have quiet conversation.

"Make the Facilitators Invisible"

In any immersive workshop, virtual or real world, facilitator interaction is key. To create adequate levels of engagement among participants, it is best when most facilitators stay completely in role and are not seen simply as observers. However, in any given exercise, for different reasons (technical, research, operational), some facilitators may simply be observers. In the real world, observers find ways to make themselves disappear to some extent in the eyes of participants. In the Virtual World, however, it was more difficult for participants to distinguish among avatars who was playing a role and who was observing. "The observers in the sim were not a problem, but having them appear as full size avatars was annoying. Can we make them invisible? Or make them into birds or trees? or how about the proverbial 'fly on the wall'? It is human nature to censor your conversation when there is an audience of unknown people. On our first world team [meaning – team in real life], we frequently have frank discussions about project issues and the client. On a few occasions I wanted to talk more freely with my team, but held back due to the presence of the observers." Interestingly, Virtual Worlds provide a way to solve the very problem it presents in this regard, as suggested by the participant. In subsequent designs of the PMRS, we turned the observers' avatars into thin clouds that would hover virtually unnoticed above participants. In this way, they could hear and see without being full-scale avatars.

"I Can't Get Outside the Sim"

One feature unique to Virtual Worlds is that people are always reachable. Designed for maximum social interaction, Virtual Worlds allow you to instant message, chat, call or teleport instantly to anyone at any time within the environment, regardless of their location. Even if you physically leave your computer, your avatar appears as though you are still in the same location. We overlooked the fact that real life provides a number of miniature "breaks" in interaction where people are able to take a moment to relax or be out of communication, even if for a couple minutes. It turns out these breaks are important our ability to carry out a task. As one participant articulated: "You need to add a bathroom to the island - four plus hours on a sim is a long time after finishing your morning coffee. I couldn't park my avatar anywhere for 2 minutes to get away. People would see me and come up to talk or ask questions. If I'm not there, then that causes problems. Just create a 'bio zone' where you can put your character when you need to step away from the sim for a moment."

CONCLUSION

High failure rates among IT implementation projects point to a lack of effective training and instructional design programs that adequately address the key needs of Project Managers facing the complexities of a global economy. After conducting an immersive rehearsal exercise with IBM Project Managers in Second Life, we set out to test a number of questions about 1) training and learning programs for developing and accelerating expertise among Project Managers, and 2) the value of Virtual Worlds for delivering complex immersive engagements to expert learners.

Rooted in decades of research into instructional design targeted at the development of expertise, our method utilized an iterative trial and error learning process suited for the kind of rehearsal necessary to develop agility and enhance skills among Project Managers with mid- to high levels of experience that would otherwise need to be learned in the real world, where workers run the risk of making expensive mistakes. After running through tow iterations of the exercise, we were able to achieve high levels of engagement among participants by creating non-negotiable outcomes and placing them in challenging, realistic scenarios. By failing on the first iteration, and then revising, reworking and redeploying a new, and ultimately successful strategy on the second iteration, participants were able to experience the consequences of inadequate strategies, receive detailed feedback, and devise new ways of thinking about and working through complex challenges in a team setting.

While the Virtual Worlds platform Second Life provided a number of opportunities for the design and implementation of the exercise, such as design flexibility, remote co-location, significantly lower costs, and granular, real-time metrics feedback, a number of issue plagued the team. Network failures arbitrarily logged off participants creating temporary disengagement and disruptions in the flow of the exercise. Unanticipated issues of observer presence, privacy, and unique communication problems not typical of real world environments disrupted some of the team's interaction. Participants often discovered ways to work around these issues and noted that in the real world, there are often unanticipated problems, which, while not the same as those in the Virtual World, nonetheless require creative solutions.

While the widespread value of Virtual Worlds for the future of instructional design remains unclear, it affords a number of opportunities, which, with improvements in the coming decades shows enormous potential for instructional designers working with global teams on complex projects.

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