Integrating Real World Experience in Designing Operations Management Course

Jenny Wang-Chavez, Ratna Babu Chinnam, Hemalatha Sathyanarayanamurthy, Joe Nguyen

Greenfield Coalition of New Manufacturing Education / Wayne State University / DaimlerChrysler Corporation

Abstract

Intense competition in today's marketplace is pressing companies to be more agile, lean, and responsive. Companies are working harder than ever to recruit graduates that not only have solid engineering knowledge, but are also abreast of best business practices, and possess the ability to rapidly diagnose and solve challenging problems. This requires engineering programs to produce graduates that are "ready to execute." This paper will use the development of an Operations Management (OM) course as an example to demonstrate the efforts made by Greenfield Coalition (GC) to produce such graduates. This paper outlines the steps taken to design and develop an industry-oriented OM course for GC where students use their knowledge, skills, and learning experiences to address real-world problems. Details on how the learning activities engage students in the active problem-solving process will also be demonstrated.

Introduction

Intense competition in today's global marketplace is pressing companies to aggressively acquire such competencies as product development agility, lean manufacturing, six sigma processes, and responsive supply chains. In response, among numerous other efforts, companies are working harder than ever to recruit engineering graduates that not only have a strong foundation in engineering knowledge, but also are fully abreast of best business practices and possess the ability to rapidly diagnose and solve challenging problems. While internship experiences used to bridge some of these gaps in the past, engineering programs are beginning to witness pressure to produce graduates that are "ready to execute" upon recruitment without having to go through a lot of orientation and training programs. To address this need in the Manufacturing Education segment, Greenfield Coalition for New Manufacturing Education, a multi-university-industry coalition housed at Focus: HOPE organization in Detroit, MI, has been working hard to produce such graduates, called a Renaissance Engineer.

Greenfield Coalition education programs focus on instilling real-world experience into the student pool by embracing "learning factory" techniques and e-learning technologies. The design and development of an Operations Management (OM) course reflect this set of beliefs and practice.

The OM course primarily focuses on the production and operations management functions that involve the planning, coordination, and execution of activities directly related to production of goods and services. This paper will use the development of this OM course as an example to demonstrate the efforts made by Greenfield Coalition (GC) to meet the needs of the current global marketplace. The paper will detail the steps taken to develop the course, the instructional strategies and activities used to engage students in the active problem-solving process, and the efforts made by the team to ensure the practical value of the course.

Greenfield Coalition Course Structure

Greenfield Coalition courses are structured into modules, sessions and activities. Each course consists of a number of modules (in some cases, the smaller courses may just have one module). Multiple sessions make up a module. A session focuses on a topic, a case or a problem to solve. Each session consists of a set of learner centered activities. In the case of the OM course, it contains four modules. Module one is made up of two sessions, module two has eight sessions, module three has six sessions, and module four has four sessions.

In the OM course, like in other courses in the Greenfield Coalition, instructors play a role of facilitator. What makes GC courses different from traditional classroom-based learning is that GC courses integrate three types of learning: classroom instructor facilitated learning, self-directed web-based learning, and experiential learning. A single session may have activities that represent any of these three components. All the decriptions of the learning activities and resources are provided via the Greenfield Course Learning System – a database driven web server.

Course Planning

The design and development team for the OM course consisted of a university faculty member (as a subject matter expert), an industry expert, an instructional designer, a programmer, and a media specialist. The design of the course started with collaboration between university faculty and industry partners to determine course objectives. The course objectives specified what students would be able to do after completing the course. Once the course objectives were validated and refined by industry stakeholders, the faculty laid out the tentative topics and modules to be covered by the course. In spite of the faculty's benchmarking efforts involving several successful operations management curricula across the nation and elsewhere, the industry experts concluded that the course lacked a real-world perspective and that the content was too "academic" in nature. Based on a number of years experience in such companies as Toyota, General Motors, and DaimlerChrysler, Dr. Joseph Nguyen (the industry partner) concluded that the primary gaps were in the effective transfer of softer operations management skills critical for success in an industrial setting. This led to a radical reorganization of the course content, significantly bridging the gap between the traditional operations management curricula and the world of practice.

The final design of the course included several complex real-life case studies and dynamic games for students to hone the skills of an Operations Manager. Students are required to take an active role in the learning process and are expected to actively participate in solving the problems that operations management personnel will likely encounter in a real-world context. After students successfully solve the given problems, they will have demonstrated the core competencies specified in the course objectives.

Design, development, and evaluation

Design framework

The mission of the Greenfield Coalition (GC) is to establish a new paradigm in manufacturing engineering education that integrates actual manufacturing experiences into the academic program and supports learning with web-based tools. GC believes that students will learn faster and better in an active learning environment solving real-world problems. Students are more motivated to learn when their learning is relevant to their own experiences and their future life in the real world [4]. Students will also learn better and faster when they take the responsibilities and control of their own learning. Based on these beliefs, GC adopted a reality-based learning approach where students must apply their knowledge and skills to address real world problems. In this active problem solving process, instructors play the roles of a facilitator, a mentor, and a coach [6].

The activities in a learning session are created based on Gagne's nine external events of instructions, which include [2]:

- Gain attention
- State learning objectives
- Elicit prior knowledge
- Present learning content
- Provide learning guidance
- Elicit performance
- Provide feedback
- Summarize concepts
- Transfer learning

The instructional strategies and sample learning activites below will provide an example that illustrates how these nine events are translated into learner-centered activities.

Instructional strategies and sample learning activities

Guided by the active learning framework, reality-based learning approach, and Gagne's instructional theory, each session is designed to include the following elements:

- Link students' experience with concepts to be learned
- Provide students with real-life problems that are meaningful
- Provide resources and tools for students to solve problems
- Have students collaborate and share solutions
- Debrief lessons learned

For example, the learning activities in the inventory management session will illustrate how a typical session is designed and how the elements mentioned above are embedded in the session. At the beginning of this session, students are first engaged in an introductory discussion about the need to learn inventory management and its importance to OM practice. This instructor-facilitated discussion helps students see where inventory management fits so that students can connect their own experience with what is under study (see figure 1).

Activity 1: Why Manage Inventory?

Discuss the following:

- Inventory management in your daily life
    - Do you maintain any inventory of goods and services for your needs in daily life? Give 2 - 3 examples for both goods and services.
    - What may be the dollar value estimate of the inventory in your kitchen pantry?
    - How frequently do you shop for all the consumables and groceries used at home? What is the logic behind this frequency?
    - What may be the disadvantages of having excessive inventory in your kitchen?
    - Can you suggest ways to reduce excessive inventory?
- Inventory management in any organization
    - Why do you think maintaining inventory is a necessity for any organization?
    - How is inventory management related to other operations in the organization?
    - What do you think of the responsibilities of an operations manager in the area of inventory management?

Figure 1: Inventory management introductory discussion

After students are introduced to the importance of learning inventory management, they are presented with a real-world problem to solve, in particular, a difficult situation faced by SB (Smart Business Co.). The problem was introduced through the meeting minutes of the Board of Directors (see figure 2).

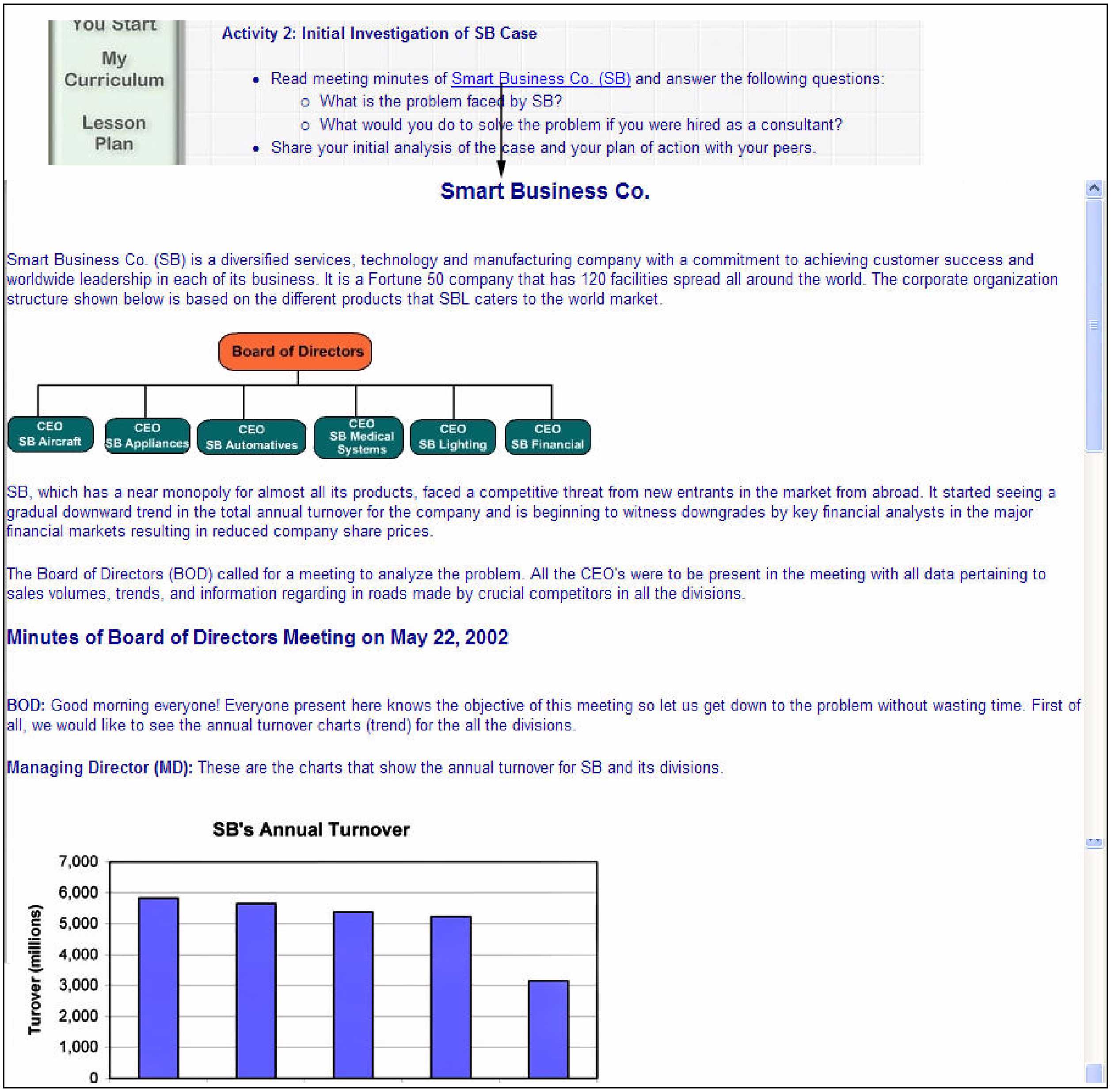

Figure 2: Inventory management case scenario

Once the problem scenario is given, students are provided with resources and tools that they can use to solve the problems. Students can work in groups, where appropriate, to collaboratively investigate the case and find the solution (see Figure 3).

Activity 3: Inventory Management Toolkit

Familiarize yourself with the tools in inventory management toolkit and be prepared to use these tools to solve problems faced by SB.

- Concepts and Principles
  - Types of inventory
  - Why not zero inventory?
  - Ways to reduce inventory
  - Why economic lot sizes?
- Techniques / Models for Managing Inventory
  - Deterministic Inventory Models
    - Economic Order Quantity Model
    - Economic Order Quantity Module with Shortages

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Activity 4: Further Investigation of SB Case

Analyze the situations of the major contributors for the reduced turnover of SB and provide solutions to the problems faced by these branches of SB.

- Solenoid Assemblies in SB Automotives
  - Data collected by the consultant
  - Your recommendations:
    - What is nature of the problem?
    - What optimal production plan would you suggest?
    - What assumptions did you make to solve the above problems?
- Christmas Tree Lights in SB Lighting
  - Data collected by the consultant
  - Your recommendations:
    - What is the nature of the problem?
    - What EOQ would you suggest for the lights?
    - If the management decides to recycle the lights instead of selling them at a discount, how will your answer change?

Figure 3: Inventory management resources/tools and case investigation

At the conclusion of the problem solving process, students will share their case findings by presenting the solutions in class or through an online forum (see figure 4).

Activity 5: Problem Solution Presentation

Present your problem solutions to the Board of Directors in SB. In this case, your instructor and classmates will play the Board of Directors. Your presentation should include:

- Problems you were trying to solve
- Methods used to determine the problems
- Recommendations to resolve the problems
- Action plan for implementing the recommendations

Figure 4: Inventory management case finding sharing

At the end of a learning session, students will have the opportunity to debrief what they have learned, which will further enrich their understanding and learning transfer (see figure 5).

Activity 6: Debriefing

Discuss the following in class:

- What are the lessons learned in solving problems faced by SB?
- What were the tradeoffs made in using inventory management models to solve the problems?

Figure 5: Inventory management debriefing

Formative evaluation

Instead of waiting for evaluation to be conducted at the end of the course development project, the design team implemented formative evaluation strategies throughout the whole design process. Formative evaluation (FE) refers to collecting evaluation data during the developmental stage for revision and improvement of instructional products [3] [7]. The primary goal of this FE was to improve the quality of the course being developed so that the desired outcome of the course would be met. FE evaluation was implemented because revised course is better than untested and unrevised products and may increase course quality significantly [5]. At the early planning stage, the industry Subject Matter Expert (SME) reviewed the course objectives and content and provided feedback. The team adopted the proposed changes and scheduled another meeting with the industry expert to validate the detailed outline of the changes. After the industry expert was satisfied with the course topics and related content, the team started a detailed design of the learning sessions. When a set of sessions in a module were designed, the team consulted with the industry expert in terms of meeting the course objective, sequence of the session topics, flow of learning activities, accuracy of the content (in accordance of world of practice), and the appropriateness of the examples and cases used. The session design was then revised to incorporate the suggestions from the industry expert. With expert review built into the design process, the project team was able to produce a quality course in a timely manner and prevented major revisions at the end.

Real world applications

The OM course emphasized real world practice and applications. Not only was the content verified by the industry partners, but several examples and cases were taken from real world settings. In addition, several interactive games were also provided to represent the real world problems and issues.

Real world examples and cases

In introducing the field of Operations Management, the course provided several video clips of interviews with operations managers in the field. Students, then, could not only hear and see what operations managers do, but also are exposed to different perspectives in various aspects of the field.

Figure 6: Interview with a senior operations manager

Involving industry partners as part of the design team also strengthened the real world applications of the course. After carefully reviewing the course content, the industry expert uncovered or identified a few gaps in the original course design as in many conventional operations management courses. Filling these gaps is critical in providing students with practical applications to the current practices in the field and in preparing students to be ready for the challenges in the future. Some of the areas that were added to the original course design include:

- Metrics of a balanced operations management. This is a balanced approach to measure and direct the performance of an operation. To our knowledge, this concept and the related practical challenges are not covered in traditional OM textbooks.
- Design and management of people systems. This session includes the core components of a people system and current practices/trends in design and development of people systems. Years of experience in the field revealed that the softer skills of an operations manager are critical to the success of managing operations. Unfortunately, very few courses in Operations Management discuss these topics. The majority of the material for this module came from the world of practice. We extensively utilized material put out by leading consulting companies and practitioners that are actively engaged in introduction and deployment of such concepts as Self-Directed Work. We strongly believe that this course helps in partially bridging this gap in contemporary OM coursework.
- Validation before regular production. In the real world, this is probably the most important aspect of operations management. However, in traditional OM coursework and even in many current practices, it has not been emphasized enough. In many companies, validation of systems is not built into the routine planning and execution process. Nowadays, most operations managers spend a lot of time firefighting at the initial launch of a new product or service instead of conducting training for their people. This session prepares students for the challenges in launching products/services and provides them methods they can use for their future jobs.

These and several other additions have tremendously strengthened the course and helped this OM course remain current and forward-thinking.

In addition to including the current practices and future trends in OM, the course was further enriched with real world cases collected from industry. These case studies were designed to help students sharpen their problem-solving skills and prepare them to be effective in operations management. Four case studies were designed using real data from NorthStar Crossover Assembly line at Focus: HOPE.

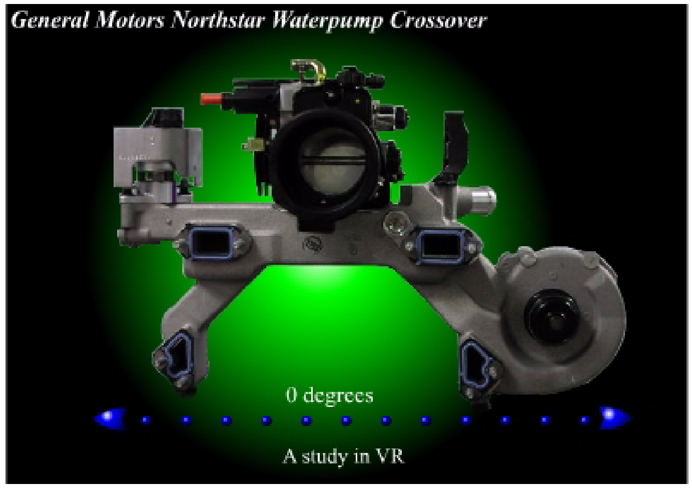

Figure 6: QuickTime VP of NorthStar Assembly Final Product

These cases are designed to help students develop working knowledge of the principles and tradeoffs in different aspects of Operations Management. These aspects include the following:

- Process and technology selection
- Manufacturing resources planning
- Total productive maintenance
- Supplier selection and evaluation

Case studies are embedded into learning sessions in such a way that will tie the major concepts in a session together. For instance, to help students synthesize what they have learned about selecting the best process and technology for a given product or service, a case regarding two assembly stations is presented for students to analyze and propose recommendations to the current situation. In this case study, a real world problem was introduced to the student groups as a wrap-up activity. Students are asked to examine the case by reviewing and analyzing case background introduction, parts to be assembled, assembly requirements, constraints faced by Focus: HOPE, and feedback and areas for improvements of the current system. The data are presented with process maps, pictures of the workstations, video clips of the assembly operations, and interview transcripts. After students analyze the case data, they are asked to present their choice of process and technology solutions and make recommendations to improve the current process and technology. In the process of analyzing data and solving problems, students can consult mentor notes as needed. The mentor notes include checklists, how-to lists, and heuristics to support students' problem-solving.

<u>Using games to represent real world problems</u>

Several interactive games were also provided in this OM course. The pull and push game helps students grasp the main concepts and principles in push and pull production, advantages of small lot manufacturing and provide students with convincing arguments of just-in-time production system. This game consists of 6 volunteer students with other students as observers and recorders of each station's output and timepiece. Among those 6 volunteers, one works as a supplier and supplies all raw materials to four workstations, one is responsible for shipping and quality control. The other volunteers, each works at one workstation, assemble cups in cup holder with straws inserted and dots placed on the cups.

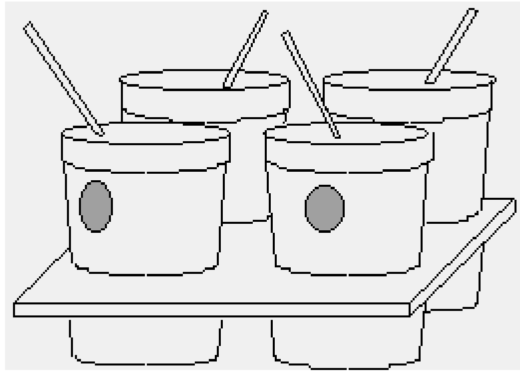
Figure 7: Push vs. Pull Game: Assembling Cups

The game plays three iterations. In the first iteration, each worker produces as much as possible and pushes work to the next station. In the second iteration, the Kanban space (adequate for 4 units) is defined on the workstations using a marker or tape at each of the workstation. Volunteers are instructed to work a new lot only when their Kanban is empty. The process turnaround time is measured with a timepiece. The third iteration is similar except that the lot size is reduced from four to two. Through playing this game, students gained insights on the real issues faced by different production systems, such as effects of lot sizing on production performance, quality control during the production vs. at the end of production, and responsive production system (push system) vs. Just-In-Time system.

Other games include the Beverage game and games on corruptive influences of variability. The Beverage Game (formerly known as the Beer Game) was adapted to help students better understand the relationships between nodes on a supply/demand chain (retailer, warehouse, distributor, and factory) within time delay and the importance of information flow in the multiple echelon system. The variation game is to demonstrate the impact variability and dependence have on workflow in a manufacturing environment. In this game, students will use pennies as output of their workstations and the output of one station is handed off to the next workstation. The random potential work is determined each period by rolling a dice. The actually work forwarded to the next station is the minimum of the number on the die and the number of items in the Work-in-Process.

After each iteration of the games, students are posed with several reflective questions. They are asked to analyze what they have observed, what issues they ran into, and what they would recommend to improve the situations or avoid problems that arose during the game.

In playing these, students are actively involved in producing and delivering products, and at the meantime, dealing with the same issues that take place in the real world. Comparing traditional teaching methods (such as lecturing, reading and comprehension), appropriate use of interactive game is predicted to enhance students' retention of knowledge [1]. In the game, students are required to interact with other individuals and team members as well as to deal with uncertainty and competitions. Using games to represent the real world problems is an effective, efficient and enjoyable way of learning. Such interactive game increases the motivations of the students in the area of attention, relevance, confidence and satisfaction [4].

The above examples demonstrated that the OM course design has bridged the gap between what is being learned and what is being practiced. Students graduating from this class will not only possess the knowledge and skills of an operations manager, but also have prepared themselves to meet the challenges in their future jobs.

Conclusion

Greenfield Coalition's close link between academic and the real world practice and the forward-thinking design and development strategies have produced many courses like Operations Management that are more engaging and practical. This and other courses at GC have blurred the boundary between real world practice and classroom learning. The strategies and the learning activities used in OM are designed to engage learners in a meaningful learning environment where their knowledge and skills will be ready to execute upon graduation. The predicted benefits and effectiveness of the instructional strategies used in OM will be further studied and validated.

GC acknowledges that not all engineering programs have such partnerships with industries. GC has been making tremendous efforts to make the courses and related resources available to other programs in the engineering community by exploiting web-based technologies and creating sharable learning objects. For more information about Greenfield Coalition courses, visit the website at http://www.greenfield-coalition.org.

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Biographies

Jenny Wang-Chavez

Jenny Wang-Chavez is a project lead and instructional designer at Greenfield Coalition at Focus: HOPE in Detroit, MI. She is also a Ph. D. candidate in the Department of Instructional Systems Technology at Indiana University, Bloomington, IN. Her work on web-based instruction, performance improvement, and integrated instructional strategies has been presented at several national and international conferences such as ISPI, AECT, ED-MEDIA and ACEE.

Ratna Babu Chinnam

Dr. Ratna Babu Chinnam is an Associate Professor in the Department of Industrial & Manufacturing Engineering at Wayne State University (U.S.A.). He is the author of several technical publications in the areas of Operations Management, Intelligent Quality Engineering, and Condition-Based Maintenance Systems. His research interests include smart engineering systems, intelligent manufacturing, process monitoring, manufacturing process control, and quality and reliability engineering. He is a member of Alpha Pi Mu, the International Neural Network Society, and the North American Manufacturing Research Institute.

Hemalatha Sathya

Hemalatha Sathyanarayanamurthy is a master's student at the Wayne State University (Detroit, US). Previously she was a Supplier-Quality Engineer at the purchase department of Motor Industries Company Limited (MICO, a Robert Bosch subsidiary in India). She received a B.S degree in Industrial Engineering from Bangalore University, India. The American Society for Quality (ASQ) has certified her as a reliability engineer. Her research interests include statistical modeling, sensitivity analysis and reliability/availability modeling.

Joe Nguyen

Joseph Nguyen graduated from San Jose State University with a Master's in Mechanical Engineering in 1981, Doctorate in Business Administration from Southern California University for Professional Studies in 1997 (summa cum laude). He worked for 15 years with New United Motor Manufacturing Inc (NUMMI), a joint venture between Toyota and GM as Manager of Quality Control Engineering. After that, he joined General Motors Corporation as director of Quality in 1990. Now he is a senior manager in Advanced Manufacturing Engineering at DaimlerChrysler Corporation.