SCOTT M. SHAFER, WAKE FOREST UNIVERSITY

2005 ASQ

This article gives an overview of how an existing MBA curriculum was leveraged to prepare students to become certified Six Sigma Black Belts (SSBB) through ASQ. Given the advanced level of many of the topics in ASQ's SSBB body of knowledge and the need to complete one or two Six Sigma projects, the goal of preparing students for SSBB certification is perhaps most appropriate for graduate-level business students. This article begins by looking at the motivation for preparing students for SSBB certification. This is followed by a brief discussion of the requirements for SSBB certification through ASQ. Next, details of how Wake Forest University leveraged its existing full-time MBA program to prepare students for SSBB certification are presented. A sample of representative projects completed by the students is then summarized to provide readers with insight into the scope of these projects. These examples also illustrate the applicability of the Six Sigma methodology to a variety of business issues and a wide range of organizations. Finally, the results after the author's first year at Wake Forest of helping students prepare for SSBB certification are discussed.

Key words: ASQ certification, MBA education, Six Sigma

A central role of business education is providing students with the opportunity to acquire skills and knowledge that will best position them to make positive and significant contributions to the organizations that employ them. Along these lines, individuals with a background in Six Sigma are presently in high demand. To illustrate, a recent search at Monster.com using the keyword "six sigma" yielded more than 2300 hits and included major organizations such as PricewaterhouseCoopers, Mckesson Pharmaceutical, Akamai Technology, American Express, GE, Geico Direct, Bank of America, Black and Decker, Humana, Owens Corning, Tyco International, and The Home Depot, to name a few. As this list illustrates, Six Sigma spans a wide variety of industries including manufacturing, consulting, technology, financial services, insurance, healthcare, and retail. Incidentally, having students perform a similar query themselves is a great way to demonstrate the value of learning more about Six Sigma and motivating the importance of the topic. It is particularly effective for nonoperations majors to see for themselves the range of organizations that are utilizing Six Sigma beyond manufacturing. With a little investigative work, perhaps prodded by the instructor, it is likely that the students will quickly discover how their marketability can be increased by coupling their background with Six Sigma. In particular, several finance majors at Wake Forest University have found that pursuing Six Sigma Black Belt (SSBB) certification is an effective way to differentiate themselves during their job searches.

As further evidence of the value industry is currently placing on individuals with Six Sigma experience,

consider the following quote taken from the letter to shareholders in the *GE 2000 Annual Report*, whose coauthors included chairman and CEO Jack Welch and president and chairman-elect Jeffery Immelt:

> "It is reasonable to guess that the next CEO of this Company, decades down the road, is probably a Six Sigma Black Belt or Master Black Belt somewhere in GE right now, or on the verge of being offered—as all our early-career (three to five years) top 20 percent performers will be—a two- to three-year Black Belt assignment. The generic nature of a Black Belt assignment, in addition to its rigorous process discipline and relentless customer focus, makes Six Sigma the perfect training for growing 21st century GE leadership."

Likewise, Barbara Desoer, who oversees Bank of America's consumer products business, expressed her opinion that being a certified Black Belt will be a necessary qualification for leadership roles across the bank in the not-to-distant future (Jones 2004). In fact, as of February 2004 there were more than 100 senior leadership positions open at Bank of America that required Black Belt certification. As a further example of the extent to which Six Sigma has been embraced by Bank of America, consider that CEO Ken Lewis completed one of the first Green Belt projects at Bank of America and required all his direct reports to complete one as well.

A question that naturally arises then is: "What is driving industry's growing interest in Six Sigma?" Perhaps the main reason for Six Sigma's current popularity is that several high-profile organizations have reported significant benefits from their Six Sigma initiatives. For example, in the three years ending in 2001, GE estimated that it saved $8 billion as a result of its Six Sigma initiatives (Arndt 2002). In the following year, GE budgeted $600 million for Six Sigma projects and targeted an additional $2.5 billion in savings (Arndt 2002). In total, one to two percent of GE employees are full-time Black Belts and 40 percent of executive bonuses are based on achieving Six Sigma goals (Arthur 2001). As another example, Bank of America obtained benefits in excess of $2 billion and increased customer delight by 25 percent in less than three years through its Six Sigma initiatives (Jones 2004). Perhaps the most dramatic example is Motorola's claim that Six Sigma has saved it more than $16 billion (Motorola 2004).

REQUIREMENTS FOR BECOMING A CERTIFIED BLACK BELT

The preceding discussion highlighted the significant opportunities that exist for individuals with a Six Sigma background. A logical question that naturally follows is: "How does one become a certified SSBB?"

Generally speaking, there are four ways to obtain Black Belt certification. Perhaps the most common approach is for employees to be trained and certified internally by their employer. In fact, based on their success with Six Sigma, some organizations actually open their training programs to people outside their organizations. Two notable examples are Motorola University (www.motorola.com/motorolauniversity) and Rockwell Automation's PowerLean certification program (www.dodge-reliance.com/power_services/preform/powerlean.html). As a side note, it appears to be a common practice for organizations to distinguish between employees who are Black Belt trained and those who are certified Black Belts. In these organizations, becoming a certified Black Belt entails meeting additional requirements beyond receiving the Black Belt training, such as passing an examination and/or successfully completing one or more Six Sigma projects.

A second approach for obtaining SSBB certification is through numerous consulting organizations that offer both training and certification programs. These organizations can be found by doing a search of the Web using a search string such as "Six Sigma certification." Third, many universities have begun offering training and, in some cases, certification programs. Several universities even offer this training and certification through online distance education programs. Finally, individuals can obtain SSBB certification through professional societies, perhaps most commonly through ASQ.

Given the wide range of options for becoming certified, it is somewhat surprising to observe the extent to which these varied certification programs are standardized, both in terms of duration and content. For example, it appears that the standard for Black Belt training is a four-month program during which students receive one week of formal in-class training each month and use the remaining time to complete a Black Belt project. Furthermore, the content of these programs often closely parallels the body of knowledge (BOK) defined by ASQ. Given this, the requirements for becoming certified through ASQ including its BOK will be briefly overviewed in the remainder of this section.

ASQ's Six Sigma Black Belt Body of Knowledge

There are two aspects to becoming a certified Black Belt through ASQ. First, individuals with three or more years of work experience in one or more of the areas defined in ASQ's SSBB BOK are required to complete one Six Sigma project. Individuals who do not meet this experience requirement are required to complete two Six Sigma projects. To evaluate the acceptability of these projects, applicants for SSBB certification must submit an affidavit for each completed Six Sigma project signed by the project champion, who does not need to be a Black Belt. Included in the affidavit is a brief description of the project's purpose related to the business objective, a description of the applicant's hands-on experience including the specific tools used, and a statement of the benefits achieved.

Once the experience requirement has been met, applicants can then sit for ASQ's SSBB examination. The exam, which covers the entire SSBB BOK, is open book and consists of 150 multiple-choice questions with a four-hour time limit.

More specifically, the ASQ SSBB BOK consists of 10 major categories. Five of these categories correspond to the define, measure, analyze, improve, and control (DMAIC) framework commonly used in Six Sigma projects. Following is a brief overview of the 10 categories that compose ASQ's BOK, including the number of questions on ASQ's SSBB exam that are taken from each category. For additional information, readers can refer to the "Certified Six Sigma Black Belt" brochure available for download at www.asq.org.

1. *Enterprise deployment* (9 questions). This category includes topics related to understanding the value of Six Sigma to an organization, the Six Sigma philosophy and its goals, and understanding the various organizational roles in Six Sigma. Enterprise deployment is further divided into the following four subcategories: 1) enterprise view, 2) leadership, 3) organizational goals and objectives, and 4) history of organizational improvement/foundations of Six Sigma.
2. *Business process management* (9 questions). The business process management category consists of three subcategories: 1) process versus functional view, 2) voice of the customer, and 3) business results. As these subcategories suggest, business process management focuses on issues related to understanding a process including its components, boundaries, owners, customers, and performance.
3. *Project management* (15 questions). Given the project nature of Six Sigma initiatives, in-depth knowledge of project management is a critical skill for the SSBB. The project management category includes subcategories on the project charter and plan, team leadership, team dynamics and performance, change agent, and management and planning tools. It is interesting to note that the first and last subcategories address what are typically considered to be traditional project management topics, while the remaining topics are perhaps more closely associated with organizational behavior.
4. *Six Sigma improvement methodology and tools—define* (9 questions). The define phase of a Six Sigma project focuses on defining the project scope, the customer requirements, appropriate performance metrics, and the problem statement.
5. *Six Sigma improvement methodology and tools—measure* (30 questions). The largest number of questions on ASQ's SSBB exam are drawn from the measure category. Measure is further

divided into six subcategories: 1) process analysis and documentation, 2) probability and statistics, 3) collecting and summarizing data, 4) properties and applications of probability distributions, 5) measurement systems, and 6) analyzing process capability. Note that the topics associated with subcategories 1 and 6 are typically covered in traditional core operations management courses, while topics in subcategories 2–4 are typically covered in core statistics courses.

6. *Six Sigma improvement methodology and tools — analyze* (23 questions). This category focuses primarily on exploratory data analysis and hypothesis testing. Like the previous category, a good portion of the topics included in this category such as regression, correlation, point and interval estimation, ANOVA, paired-comparison tests, goodness-of-fit tests, type I and II errors, and so on are traditionally covered in the core statistics course.

7. *Six Sigma improvement methodology and tools — improve* (22 questions). This is one of the more technical areas in the BOK and includes subcategories on the design of experiments, response surface methodology, and evolutionary operations.

8. *Six Sigma improvement methodology and tools — control* (15 questions). This category's emphasis on statistical process control will generally overlap to some extent with traditional operations management core courses. Included in this category, however, are a number of advanced statistical control applications, as well as the use of lean tools for control that usually are not covered in the core operations management course.

9. *Lean enterprise* (9 questions). Topics such as the theory of constraints, cycle-time reduction, and continuous flow manufacturing in this category will likely overlap with traditional core operations management courses. This category also includes subcategories on lean tools and total productive maintenance, which probably do not overlap much with required courses but may overlap with electives.

10. *Design for Six Sigma (DFSS)* (9 questions). Like the previous category on lean enterprise, the DFSS category could be considered a complete discipline in its own right. In ASQ's BOK, this category is further divided into five subcategories: 1) quality function deployment (QFD), 2) robust design and process, 3) failure mode and effects analysis, 4) design for X (DFX), and 5) special design tools.

MEETING THE REQUIREMENTS

Wake Forest University's full-time MBA program is similar to other nationally ranked programs. It is a two-year program, with the first year consisting primarily of the required core courses and the second year consisting of primarily electives. While not required, the majority of students participate in a summer internship between the first and second years.

With the market for MBAs becoming increasingly competitive, the considerable interest in Six Sigma from industry appeared to offer Wake Forest University a significant opportunity to help differentiate its full-time MBA program graduates. (Table 1 provides additional background information about Wake Forest's 2004 full-time MBA program graduating class.) The most significant challenges the university faced in helping its students obtain SSBB certification prior to graduation included initially identifying and communicating with the set of students who had an interest in pursuing SSBB certification, obtaining a sufficient quantity of student SSBB projects from the local business community, and aligning the existing curriculum to address ASQ's BOK.

The challenge of identifying and communicating with the students arose because the operations management group decided to help students become certified Black Belts after they had already completed their core operations management class. Therefore, in an effort to identify students, the faculty from the operations management group attended a meeting of the Operations Club prior to the completion of the students' first year of the program and presented its perceptions of the Six Sigma opportunity. A key aspect of this meeting was encouraging students to consider how they could use their summer internships to meet

Table 1 Characteristics of Wake Forest University's 2004 full-time MBA class (Wake Forest University 2004).

Class size	116
Percent U.S. citizens	72%
Percent female	26%
Percent minorities	10%
Average GMAT score	641
Average years of full-time work experience	4.0
Average age at entry	27
Percent with undergraduate degree in business	28.5%
Percent with undergraduate degree in social sciences or humanities	28.5%
Percent with undergraduate degree in physical sciences or mathematics	24%
Percent with undergraduate degree in engineering	19%
Percent of MBA graduates with first concentration in operations management	12.9%
Percent of MBA graduates with second or third concentration in operations management	8.6%

one of the project requirements. Wake Forest is presently in its second iteration of helping students become certified SSBBs, and in this iteration the operations management group has done a better job communicating with the students. In particular, a lecture on Six Sigma has been added to the first-year core operations management course that provides an overview of the topic and highlights opportunities for students to pursue certification in conjunction with their normal studies.

The second challenge the university faced was identifying a sufficient number of Six Sigma projects. In the first iteration, 14 students signed up for independent studies to complete a Six Sigma project. As it turned out, finding companies and selling them on sponsoring Six Sigma projects was much easier than expected. In particular, the selling part was greatly facilitated by the inherent mutually beneficial nature of these projects. From the organization's perspective, these projects provided free consulting from MBA students on projects driven by the hard analysis of actual data. Furthermore, an important difference that was observed between student Six Sigma projects and other student field projects was that with Six Sigma projects there was the added requirement beyond receiving a grade of getting the project champion to sign off on a project affidavit attesting to the actual business results that stemmed from the project. From the student's perspective, these projects helped them obtain a marketable professional certification in addition to providing them with a rigorous learning experience. Furthermore, these projects provided students with valuable work experience that could be leveraged during the interview process as tangible evidence of their analytical skills. From the instructor's perspective, the DMAIC approach helped structure projects that would otherwise be poorly defined. In addition, these projects were completed individually, thereby eliminating any potential problems with coattail riding.

In terms of identifying organizations to sponsor the projects the university relied on three primary sources. First, Wake Forest already has on the books a course called Management Consulting Practicum (MCP). In this class, teams of students serve as outside consultants to local businesses. Organizations are able to submit projects for this course by completing an online form. In addition, a program director also solicits projects from the local business community. Typically, there are far more projects available each year than student project teams, so the initial source for Six Sigma projects was the leftover MCP projects whose problem statements appeared to be a good match for a Six Sigma project. The author contacted each of these organizations to make sure they were comfortable having their projects completed by a single student as a Six Sigma project as opposed to a team-based MCP project. Upon learning more about Six Sigma, all contacted organizations agreed to have their projects tackled using the Six Sigma approach.

The second source for identifying student projects was faculty contacts.

In particular, the author recently made a presentation at a joint ASQ/APICS meeting, and at the

Table 2 Matching existing courses at Wake Forest University to ASQ's SSBB BOK.

SSBB BOK Topic	Core Course(s)	Elective Course
Enterprise deployment	Operations management	Business process management
Business process management		Business process management
Project management	Operations management and organizational behavior	Project management
Define		Business process management
Measure	Quantitative methods	Business process management
Analyze	Quantitative methods	Business process management
Improve		Business process management
Control	Operations management	Business process management
Lean enterprise	Operations management	Business process management
Design for Six Sigma		Business process management

beginning of the presentation made a short commercial related to opportunities and benefits associated with sponsoring student projects. Needless to say, this resulted in obtaining a number of business cards at the end of the presentation.

Finally, the students themselves can serve as an excellent source of Six Sigma projects. For example, students may be able to line up Six Sigma projects with the organizations they did their summer internships with. This has the added benefit for the students of maintaining and even enhancing their relationships with previous employers, which may in turn help translate these internships into full-time job offers. Also, current part-time students in working professional programs can be an excellent source for Six Sigma projects.

The final challenge the graduate business school faced related to aligning its curriculum with ASQ's SSBB BOK. On the surface this appeared to be the most daunting challenge because at the time the university had an interim dean and during this period it was decided to freeze the curriculum. Therefore, we had to make do with the classes that we were already offering. In actuality, providing students with a solid foundation in the SSBB BOK required only minor incremental changes to the business process management second-year elective.

Table 2 summarizes how Wake Forest's existing courses matched up with ASQ's SSBB BOK. As shown in the table, its existing first-year courses (without modification) in operations management, quantitative methods, and organizational behavior had considerable overlap with the SSBB BOK. Likewise, its second-year elective on project management matched up nicely with the BOK category of the same name. Therefore, the only change made to Wake Forest's curriculum in the first iteration was incorporating more Six Sigma topics into its existing business process management elective to plug the major gaps in its coverage of the BOK. In the final analysis this resulted in increasing Six Sigma topical coverage from a third of the course to half the course. The Six Sigma topics included in the business process management class included:

- The DMAIC framework
- Process performance measurement, including calculating defects per million opportunities and rolled throughput yield
- The customer-driven enterprise
- The cost of quality
- Basic Six Sigma tools such as process mapping, cause and effect diagrams, and the 7M tools
- Measurement systems analysis

Table 3 Summary of representative student Six Sigma projects.

Project title	Project objective	Projected benefits
Investigation of raw material variance within the stamping process	Reduce the raw material variance and implement process controls to improve accuracy of scrap parts and metal reporting.	Annual cost savings of $50,000
Productivity improvement in stamping process	Reduce scrap caused by ineffective reeling and to increase productivity.	Annual cost savings of $60,000
Quality adaptation at Company X	Determine areas in the process where improper testing is taking place.	Procedural checks reduced by 65%, which is projected to yield savings of $70,000 to $300,000 depending on volume.
Investigation of inventory spill	Identify and mitigate inventory spill in the warehouse.	Projected benefits include a 31% reduction in cost, 39% reduction in required warehouse space, and approximately $400,000 reduction in inventory.
Investigation of sales returns	Identify the drivers of merchandise returns at a catalog retailer.	Projected annual savings of $250,000
Analysis of schedule performance	Analyze the schedule performance metric currently used.	Developed a more accurate measure of schedule performance
Setting productivity standards for nurses	Develop productivity standards for nurses.	Projected annual cost savings in excess of $200,000

- Statistical process control (building on the foundation set in the core operations management course)
- Process capability analysis
- Design of experiments
- Design for Six Sigma
- Lean manufacturing

FIRST-YEAR RESULTS

Despite the challenges the university faced in implementing a program to help students become certified Black Belts, the results are encouraging. In the first iteration, 14 students completed a total of 17 projects. As will be discussed further in the next section, these projects proved to be mutually beneficial for the students and the sponsoring organizations. Three students managed to complete two Six Sigma projects, qualifying them to sit for ASQ's SSBB exam. Two of these students completed the two projects during the normal academic second year of the program in addition to completing their regular course work, while the other student completed one project during the academic year and used his summer internship for the other project.

Two of the three students who qualified to sit for the ASQ SSBB exam sat for it in Wake Forest University's own seating of the exam. Since its classes ended at the end of April 2004 and graduation was not until mid-May, the university arranged with ASQ to host its own seating of the exam in the second week in May 2004. This provided the students with some additional time for focused study during which they worked through the *CSSBB Primer* (QCI 2001a) and CD-ROM (QCI 2001b) distributed by the Quality Council of Indiana. Wake Forest reports that its students achieved a 100 percent pass rate on its first special seating of the exam. The third student deferred taking the exam until October given the stress associated with relocating and starting a new job. Incidentally, it is worth noting that ASQ required that the certification exam be proctored by someone who had not had the students in class to avoid any potential conflicts of interest. Therefore, the university contacted the vice president of education of the local section of ASQ and worked with him to identify a proctor for the exam.

REPRESENTATIVE STUDENT PROJECTS

As noted earlier, 14 second-year students completed a total of 17 Six Sigma projects in the first iteration. To provide additional insight into the applicability and scope of these projects, Table 3 summarizes a representative cross section of the projects completed. Several of these are discussed in the remainder of this section to provide readers with additional insights into these projects.

As a manufacturing example, one project at an electronics manufacturer focused on reducing the raw material variance within a stamping process and implementing process controls to improve the accuracy of scrap parts and metal reporting. This particular project was not typical in the sense that the sponsoring organization had significant experience with Six Sigma. In completing this project the student used many of the basic Six Sigma tools, including process mapping, cause and effect diagrams, and Pareto analysis. In addition, because of the sophistication of the sponsoring organization, a detailed gauge R&R study was completed using Minitab. The annual cost savings resulting from this project were conservatively estimated to be $50,000 and were achieved by reductions in premium freight and line down charges.

As an extension to this project, the student completed a second project that focused on reducing scrap caused by ineffective reeling, and increasing productivity through the standardization of packing reels by minimizing reeler set-up errors and reducing setup times. The annual cost savings of the second project were estimated to be $60,000.

In reviewing these two projects, a few observations are offered. First, ideas for follow-up projects are common given the incremental and narrowly defined nature typical of Six Sigma projects. Second, there is a significant start-up cost each time a student undertakes a project with a new organization. Therefore, students can use their time more efficiently by completing the two projects at a single organization. Since organizations tend to define their problems broadly, faculty advisors can play an important role here in helping partition a broad problem statement into multiple well-defined Six Sigma projects. In other cases, students may be able to build on their summer internship experiences. Of course, some students may prefer to trade off the efficiency associated with working with a single organization for a broader learning experience that comes from working with multiple organizations.

As another manufacturing example, a producer of food condiments was having a problem with the amount of floor space its inventory was taking up. The student assigned to the project began by collecting production and warehouse data. These data were used to develop a model to evaluate alternative batch sizes and batch sequencing for a product bottled in five different container sizes across two bottling lines. In addition to considering the cost of alternative solutions, the model incorporated production and demand rate data to estimate total floor space requirements. In the end, the project reduced costs by 31 percent, produced a 39 percent floor space savings, and reduced inventory levels by approximately $400,000.

It is particularly effective for nonoperations majors to see for themselves the range of organizations that are utilizing Six Sigma beyond manufacturing. With a little investigative work, perhaps prodded by the instructor, it is likely that the students will quickly discover how their marketability can be increased by coupling their background with Six Sigma.

As a service example, another student project addressed the problem of merchandise returns at a catalog retailer. The student initially performed Pareto analyses on what was returned and the reasons for the returns. Based on the results obtained, important factors were further analyzed across a number of additional variables, including customer location, the discount policy, and product group. While the goal of the project was to help management better understand the drivers of merchandise returns, the project highlighted potential annual savings of $250,000.

Finally, as an example of the application of Six Sigma to a nonprofit organization, a student project was completed at a hospice and palliative care unit. More specifically, this project focused on the development of productivity standards for the nurses. The student began by collecting historical data on patient treatment times, travel times, and administrative times. Theoretical distributions were then fit to the collected data in each of these categories. Using these theoretical distributions, a simulation model was created and used to generate the distribution associated with the overall time to treat a single patient. This distribution was then used in another simulation model to evaluate alternative nurse staffing strategies. It was projected that the care provider could save in excess of $200,000 annually by following the nurse staffing guidelines recommended by the student.

CONCLUSIONS

Occasionally, even those in other disciplines must think like their colleagues in marketing. Such was the case for the operations management group at Wake Forest University where it identified an opportunity to align its existing curriculum with the current interest in Six Sigma.

At the outset, it is important to address the most obvious risk the group faced in pursing this opportunity. Namely, that they were simply jumping on the bandwagon of the latest management fad. While Six Sigma may not be as hot of a topic three years from now as it currently is, it is more than merely a fad. As an analogy, in the mid-1990s some pundits argued that the Web was merely a fad and would go the way of the CB radio. It did not because of the tremendous value it created. Once people got used to the convenience, ease of use, power, flexibility, and so on of using the Web, there was literally no turning back. The author believes the same is true of Six Sigma. In particular, once organizations become accustomed to making decisions on the basis of rigorous and disciplined analyses of data, there is no turning back. Already, the value of the Six Sigma approach has been demonstrated by numerous companies such as GE, Bank of America, and Motorola. Therefore, while it is almost certainly true that in the future Six Sigma will receive less top-of-mind attention than what it currently garners, this does not automatically imply that it was just another management fad. Rather, it may simply indicate that Six Sigma has become accepted and integrated as a standard business practice.

Both students and faculty have benefited from Wake Forest University's Six Sigma initiatives. From the student perspective, there is anecdotal evidence from a number of students that their course work in Six Sigma facilitated their jobs searches. One student, who accepted a position with a major financial services firm in New York, stated unequivocally that the material in the business process management course got him the job. From the faculty perspective, mentoring students through their Six Sigma projects is extremely labor intensive, often requiring an hour or more each week with each student. At the same time, working with students in this fashion provides opportunities to get to know them better and ultimately build stronger relationships with them. Personally, the author found the shift in role from instructor to coach intrinsically rewarding. A final benefit observed was increased interest in operations management courses.

As this article was being written, the university's second iteration was underway. In this iteration faculty members did a better job of initially communicating with the students, primarily through the first year core operations management course. As a result, they estimate that approximately 20 percent of rising second-year students are structuring their summer internships to meet one or both of their Six Sigma project requirements.

In addition, this year Wake Forest has restructured its full-time MBA program and added a number of half semester electives in the first year of the program. These electives were added to provide students with in-depth skills in a particular area in order to better prepare them for their summer internships. Since an elective on Six Sigma appeared to be ideally suited to this objective, the operations management group will offer such an elective this coming year. Thus, students passing through the third iteration will have the

opportunity to take a Six Sigma elective during their first year of course work. Having this elective in the first year will permit more advanced coverage of Six Sigma topics in the second-year electives.

Overall, Wake Forest's experience with integrating Six Sigma into its operations management offerings has been extremely positive. It has resulted in numerous benefits for students, faculty, and the local business community. However, consistent with the Six Sigma philosophy, process improvement is a never-ending cycle. Therefore, while the university's initiative has already evolved considerably from the first iteration recently completed to the third iteration, which will be started later this year, almost certainly additional enhancements will follow in the ensuing years.

REFERENCES

American Society for Quality. 2004. Certified six sigma black belt brochure. See URL: www.asq.org/cert/pdf/ssbb_brochure_04_2.pdf.

Arndt, M. 2002. Quality isn't just for widgets: Six sigma, the quality-control and cost-cutting power tool is proving its worth on the service side. *Business Week* (July 22): 72.

Arthur, L. J. 2001. *The six sigma instructor guide.* Denver: Lifestar.

GE 2000 annual report. See URL: www.ge.com/annual00/download/index.html.

Jones, M. H. Jr., 2004. Six sigma...at a bank? *Six Sigma Forum Magazine* (February): 13-17.

Motorola. 2004. What is six sigma? See URL: www.motorola.com/content/0,,2409-4904,00.html, September 9.

QCI. 2001a. CSSBB Primer. See URL: www.qualitycouncil.com/cssbb_p.asp

QCI. 2001b. CSSBB Electronic Exam. See URL: www.qualitycouncil.com/software_exam.asp

Wake Forest University. 2004. *Babcock recruiting guide 03-04.* Winston-Salem, N.C.: Babcock Graduate School of Management.

BIOGRAPHY

Scott M. Shafer is an associate professor of operations management at the Babcock Graduate School of Management at Wake Forest University. He received his current appointment with Wake Forest University in August 1998. Shafer received a bachelor's degree in industrial management in 1984, a bachelor's degree in marketing in 1984, and a doctorate in operations management in 1989 from the University of Cincinnati.

His current research interests are in the areas of cellular manufacturing, operations strategy, business process design, organizational learning, and business modeling. A study investigating the productivity of 738 researchers in the field of operations management ranked Shafer in the top 20 in terms of both publication quality and research productivity. His publications have appeared in journals such as *Management Science, the Journal of Operations Management, Decision Sciences, International Journal of Production Research, OMEGA, IEEE Transactions on Engineering Management, International Journal of Operations and Production Management, International Journal of Purchasing and Materials Management, Production and Inventory Management Journal, Journal of Corporate Accounting and Finance,* and *Project Management Journal.* He is also a coauthor of six books in the fields of operations management, project management, and quantitative business modeling. He can be reached by e-mail at scott.shafer@mba.wfu.edu.