Sacred Heart UNIVERSITY

New England Journal of Entrepreneurship

Volume 6 | Number 1 Article 9

2003

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Following a successful career in industry, Dr. Douglas V. Shick, a newly minted entrepreneur, established NRS Associates, LLC, to perform consulting services based on two highly technical computer-modeling programs. Doug was heavily involved in the development of one program, an innovative computer simulation software for modeling a particular manufacturing process, through intrapreneurial activity during his corporate experience. Doug established his business on September 1, 2001, and on September 10 announced his services by e-mail to everyone he knew. The unforeseen events of the next day, September 11, produced some unexpected aftereffects that Doug had to factor into his developing business.

In late spring 2002, Doug Shick was sitting in his home office, thinking about adding another link to his company website. He looked at the Visa/MasterCard credit card reader next to his computers and wondered how soon—or long—it would be before he would ring up another sale. What a six months it had been! He had made the leap directly from industry to entrepreneurship. He had worked through every imaginable business scenario before setting up his new business venture—a high-technology consulting service based on two very sophisticated computer analysis programs. He'd also spent 70 days as a ski instructor, because of the unexpected downturn in the economy. Skiing certainly wasn't in his original business plan—but then neither were the events of September 11. Surprisingly, the skiing had brought forth some unexpected business-related benefits. Where, he wondered, would his next lucky break come from?

From Intrapreneurial Engineer to Prospective Entrepreneur

Doug's Career in Industry

Doug has been involved in solving complex engineering problems using state-of-the-art computing resources for his entire professional life. Following receipt of his bachelor's degree in physics in 1976 from Bates College in Lewiston, Maine, he obtained both the master's and the Ph.D. degrees in mechanics in 1979 and 1984, respectively, from Rensselaer Polytechnic Institute. Between 1985 and 1990 he was first a post-doctoral fellow, and later a research associate. In 1990 Doug left academe and became employed by the Advanced Technology Center of the Ingersoll-Rand Company in Torrington, Connecticut, first as a research engineer, and later advancing to the position of manager, engineering analysis and technical services.

In his positions at Ingersoll-Rand, Doug further developed his skills in computer modeling and solving complex technical problems, and also set up computer networks within his department. The latter responsibilities required him to coordinate his efforts with the corporate information technology (IT) organization. In addition, he had special assignments as part of his daily work routine, two of which involved setting up and administering his department's annual operating and capital expenditure budgets. Although these budgets had to follow established corporate guidelines, he nevertheless became very familiar with budgeting and financial issues, especially when he sought exceptions to the guidelines. In addition, he learned human resource and people skills through various courses and seminars and, more practically, from managing the 12 skilled people who worked directly for him. In these situations, his manager provided coaching and watched his leadership skills improve over the years as Doug progressed through promotions from an individual contributor to supervisory and then management-level positions.

In performing corporate R&D, Doug had to generate and develop ideas that would benefit some group of internal customers within the company. These customers were usually the engineering departments in the manufacturing divisions. Doug's ideas might have their origin in a problem that the customer was experiencing, or the idea might be one of Doug's own creation to advance the future capabilities of the company. In each case, going forward required Doug to generate a project proposal complete with resource requirements, expected milestone completion and project review dates with his customer, and the project's funding requirements. Finally, Doug had to "sell" (obtain approval) this proposal to the engineering manager of the department that would fund the project. Several iterations of the project proposal between Doug and the engineering manager to refine the details would not be unusual. They needed to have confidence in Doug's abilities to produce what he said he would produce, and Doug needed to understand exactly what the division wanted and how they would use the results from the proj-

ect. Doug had a long string of successful projects that contributed to significant new business opportunities for the company.

First Thoughts of Entrepreneurship

Doug never intended to become an entrepreneur. He was content with his career as an R&D engineering manager in a Fortune 500 company. As a key contributor in his department and as a respected manager, Doug was concerned with the future direction of the company in general and his department in particular. During the late 1990s and early 2000s, downturns in manufacturing resulted in several restructuring events. Doug's group was eventually affected by these actions, and alternative arrangements were a hot topic. On one assignment he worked with his current manager to develop "blue-sky ideas" as to what would be involved with spinning off the R&D function of the company and taking it private. The analysis showed that such a scheme would be unrealistic. However, as Doug remembers, "…that kind of got me thinking about doing this for myself,…but at first the idea of doing it on my own wasn't something that even really occurred to me." Doug worked more on the idea of taking himself private, feeling as he did that his future career path did not look as promising as it once did. Setting up a consulting business now took on a growing appeal. Subsequently, Doug informed his manager that he could consider Doug in any future restructuring actions.

Interestingly, Doug's intrapreneurial activities in industry provided the pathway to entrepreneurship. His involvement with developing a specialized software program, and later working with a collaboration of intrapreneurs on the same program, provided the impetus for him to consider the possibility of making his entrepreneurial debut as a consultant.

First, the Engineer as Intrapreneur: NCMS and Heat Treat Distortion Prediction

One of Doug's extra responsibilities was as the Ingersoll-Rand representative in a multipartner collaborative R&D program under the auspices of the National Center for Manufacturing Sciences (NCMS 2003). The collaboration developed a software program, later christened Dante™, which would subsequently become a key offering in Doug's business. Several years prior to becoming a member of this collaboration, Doug had initiated his own R&D project to try to solve the very problem that ultimately led to the formation of the collaboration. The need for this R&D was widely supported in his company. When the opportunity arose to join the NCMS collaboration, and work with other highly talented team members from NCMS member companies on this same problem, approval came quickly.

The Collaboration

NCMS forms and manages complex, multipartner, precompetitive collaborative R&D programs among its member companies. An act of Congress, the National Cooperative Research and Production Act of 1984, enabled the formation of NCMS. The goal of this collaboration was to develop a software program that predicted how a steel part of any geometry would change its shape, or distort, after being subjected to the high temperatures and rapid quenching that characterize the steel hardening process. The primary reason to harden steel is to improve wear resistance. Some aspects of hardening steel resemble elements of the process used by the blacksmiths of a bygone era when they heated a part to red/orange heat, shaped it on their forge, and then quenched the part into a liquid medium such as water, brine, or oil.

For the most part during this collaboration, Doug worked in his Ingersoll-Rand office—his assignments and responsibilities to the NCMS collaboration were just other items on his work agenda. He communicated with his colleagues on a regular basis and attended meetings at NCMS headquarters or elsewhere as scheduled. Doug also led a subteam during one phase of the program, which further enhanced his management skills since none of the members reported directly to him. Doug's and his colleagues' innovative work on the software program was much like that of a group of intrapreneurs innovating on behalf of their respective organizations.

A Major Decision

Once the software was successfully developed, the collaboration members made a unanimous decision to "commercialize" the software and make it available to the public. Following the evaluation of several alternatives, the collaboration team selected Deformation Control Technology (DCT) (DCT 2003), one of the original collaboration partners, to perform this task. This commercialization process made the code more user-friendly for potential purchasers and users, compared to the raw code developed by the collaboration engineers. The Dante™ software worked in a professional manner like any other high-technology software one might purchase or license on the open market. Even though Dante™ would ultimately become available to the general public, the collaboration members felt that they were still in the position of gaining the maximum benefit from the software because of their intense involvement with developing the original code and understanding every nuance of the software.

Doug and his collaboration partners brought a solution to this complex problem to the point where it could now be commercialized and then sold on the open market. Doug had just experienced a major intrapreneurial event, thanks to NCMS and ultimately the U.S. Congress! And Dante™

would soon form the basis of Doug's major entrepreneurial undertaking.

Evaluating Entrepreneurship

Financing

As Doug thought about "taking himself private," he first evaluated his financial resources. Fortunately, Doug's family situation was such that he didn't need to generate cash flow from "Day One." He had been saving funds in anticipation of starting his business enterprise, and he also had a separation package from Ingersoll-Rand that he earmarked for setting up his business enterprise. His wife had a stable, corporate position, and they had no children. With his separation package and accumulated savings, Doug had a "buffer" of about $65,000 to establish his business enterprise and carry it through the start-up phase of development.

There were ongoing expenses associated with establishing his new business enterprise that were not trivial. Actual fixed business expenses were approximately $6,500 per quarter. There were a number of variable expenses, such as travel to national technical society meetings and meetings with prospective clients, but these would be reduced to some extent by the potential for generating revenue. There were also some one-time fixed expenses associated with setting up his home office. As a potential source of future financing, Doug opened a home equity line of credit on his Connecticut residence while he was still employed.

Business Planning and Evaluating Risks

After finally accepting that his current position no longer held potential for advancement, Doug applied an analytical process to study alternatives. He used commercially available business-planning software to analyze various business scenarios to evaluate the risk of setting up a business enterprise. "I started looking at what would it take to make a go of it. Worked out some business plans and assumptions . . . . that maybe the first month in business I might bill 35 hours, and ramped it up by 5 hours a month until I was selling 80 hours a month, and then I would be doing probably just about as well as I was doing before." He also evaluated the impact of different ramp rates as well as the impact of taking three months before achieving his first paying job, and even six months, attempting to be conservative in his projections.

Doug considered various hourly rates for his services, ranging from $75–$100 per hour for routine or general structural analyses to $125–$150 per hour for more advanced premium analyses using Dante™. Since there was more competition from other consultants providing general structural analyses, he knew from his experience with such consultants while in industry that he would have to charge a lower hourly rate for these services. Doug anticipated that this class of analysis would provide the majority of his revenue. Doug also evaluated various ratios of premium to routine analysis, still recognizing that the majority of his analytical work would fall into the routine category. After evaluating the results of the different scenarios, Doug was confident that he could be successful.

Before setting up his business, Doug sent his résumé to several firms that provided computer analyses for their business clients. This generated positive interest. Both as a contingency plan and as a safety net, Doug felt that he could obtain employment at this type of firm on relatively short notice should he decide to abandon his business enterprise in the future.

Legal Organization

By now the desire to set up his business enterprise became compelling. "The more I thought about it, the more I wanted to be on my own. I'd be completely in control of what I did …. sort of—in reality you do whatever anybody will pay you for. The flexibility of working either in Connecticut or in Vermont where we have a vacation home was particularly appealing."

Doug read up on business types and organizations, and how to start a company. Working with an attorney, he formed a LLC (Limited Liability Corporation) organization structure. He registered his new company using his home address in Connecticut.

Final Analysis

Doug was confident that he had realistically viewed his prospects and evaluated the risk potential. Reflecting back on the thought process he used to evaluate the present and the future, Doug said:

> *I tried to make sure I thought of things that could go wrong, (to) try to identify the ones that would just kill something, and (to) make sure that I knew either how I can keep them from happening or how I would respond in case they did. It wouldn't be much fun to be focusing constantly on the problems, and at the same time it would be foolish not to worry about them at all. I was pretty happy with the way things looked. The element of risk was there, and I thought I had considered every contingency. Even the worst case was survivable. I like doing the technical work, but I also like managing stuff and being the boss. This business venture gives me both things. It's my company that I have here. I get a charge out of looking at my brochure that says 'NRS Associates, Douglas Shick, President.' I talk about myself as the founder. . . . But I hadn't considered the impact of the tragic events of September 11.*

Opening for Business

In August 2001 Doug left industry to start NRS Associates, LLC. NRS stood for the phrase "Not Rocket Science." Doug explained his choice of name as follows. "A friend said I should have something whimsical—and I sort of thought something serious. So this way I can do both things. I can be whimsical with Not Rocket Science and serious with NRS." On Doug's website, www.nrsassoc.com (NRS 2003), he elaborated further on the name NRS, writing, "In the words of our founder, 'Okay, maybe it's Not Rocket Science, but it's still awfully complicated.' Our mission is to provide simple solutions to the complex problems faced by our clients."

Doug established his high-technology business venture on September 1, 2001, and on September 10, he e-mailed an announcement detailing his technical services to everyone he knew. In return, he had a number of congratulatory replies, as well as some significant leads.

NRS's Services: Computer Modeling of Mechanical Components

Doug's clients wanted to know whether—or when—a particular mechanical part will fail once in service. The news media periodically carried stories of catastrophic failures; for example, a tail-rudder failure that was suspected of causing an airplane crash, but structural failures regularly occurred on a more mundane level as well. Computer-based analytical tools that predict how a virtual part or component will respond under various service conditions were an important part of providing reliable quality products. Structural modeling with computer simulation software has replaced the need for real-time testing of every component. Computer simulations provided the information required to assess the likelihood that a given component will fail in service. Many businesses had engineers on staff with the expertise and experience to provide such analyses, while others relied on consulting services such as Doug's on an as-needed basis.

Structural Analyses

Technical computer modeling or simulation is to the engineer what EXCEL™ or another business spreadsheet program is to the business manager. Just as a business manager performs a number of "what-if" analyses in studying a given business scenario, inserting different values of the business variables into the spreadsheet as part of generating an understanding of that scenario, a design engineer performs high-technology computer modeling or simulation to gain an understanding of what is happening to a given structure or component under load or other input from its service environment. Seeing what happens to a component under different conditions enables the engineer to make any needed design changes that become evident during the analysis and to have confidence in the final design of the component before actually building a prototype. Finally, physical testing of the prototype through actual experimentation and comparing its performance or response to its working environment with the predictions from the computer model generates a very high degree of confidence in the performance of that component before manufacturing begins and the component finally reaches a customer.

Home-Based Structure Modeling

Solving structural analysis problems required an incredible number of calculations. A decade ago, these calculations required the use of mainframe computers, making it impossible for the lone entrepreneur to set up his or her own dedicated computing system. However, the tremendous increase in computing power at reduced cost had made it possible for individuals like Doug to have the ability to perform these complex computer analyses in their own home.

Doug leased a state-of-the-art workhorse computer from Dell to perform the heavy computation, and a laptop computer that would enable him to provide the input parameters from any location at any time, whether from the same room, a distant location such as a customer's office, or his family vacation home in upstate Vermont. The laptop also displayed the final results. Quarterly computer lease charges were about $1,200. A simple modem connection from his laptop computer provided the necessary link from any off-site location to his office network and workhorse computer very effectively. Other expenses, such as dial-in access, cable Internet access, and web site charges, were approximately $240 per quarter.

Doug Offers Two Services: ANSYS™ and Dante™

Doug's company provided two services: routine or general structural analysis and specialized or premium computer modeling analysis. Each service required a different software program with different associated charges.

ANSYS™

Doug licensed a software program from Ansys, Inc. (called ANSYS™) that enabled him to analyze mechanical structures and components, and to make recommendations to his customer about the ability of the component to safely withstand the applied loads in service without undue stress concentrations that would lead to premature failure of the component (ANSYS 2003). Doug's ANSYS™ license cost about $5,000 per quarter.

Dante™

Doug was well aware that Dante™ represented a significant advancement in the realm of computer analysis software. He recognized that moving Dante™ into the marketplace would be a challenge—it was a high-technology innovation in complex computer simulations not previously available in the marketplace. It was a first—it was new to the world. "We're dealing with customers who didn't know they needed it—I guess that's what we're kind of struggling with . . . not struggling, but that's the next step. It's a matter of finding the right customer and showing them what it can do and they can figure out what to do with it."

Doug licensed Dante™ for his business enterprise from DCT. Dante™ enabled Doug to predict for his customers how a steel part would distort, or change its shape, during the operation that involved hardening a steel component. A way to predict this distortion would offer several options to a manufacturer to minimize this effect. Dante™ can be extremely important in new product development, bridging the gap between product design engineers and manufacturing engineers. With Dante™ various designs and their manufacturing consequences can be studied before a new design was finalized and manufacturing was left with the challenge of making the part.

Doug had a second license from DCT to sell the Dante™ software outright in the northeast region of the United States. Because of this sales relationship with DCT, Doug did not pay a fixed annual license fee for his business use of Dante™, just royalties as a percentage of his fees for jobs where he used Dante™. These royalties to DCT acknowledged the intellectual property contained in Dante™ that DCT developed during the commercialization process.

Marketing Plans and Networks

Doug established his website, www.nrsassoc.com, himself, at minimal cost by drawing on his overall IT competency. He designed the website more as a means to demonstrate the credibility of his business enterprise than with the expectation that it would bring in cold leads. His website described his services and also contained links to other consultants, technical analysis software companies, and laboratories that provided various kinds of services that were complementary to Doug's. He incorporated an IT principle that the more sites that were linked to yours, the more likely a search engine would think you were important and place your site near the top of any search list. In addition, Doug made sure that his homepage contained important keywords that a person seeking his kinds of services might use in their search. The benefit of these strategies was that anyone who used a search engine to search for these services was likely to find Doug's website relatively easily. Doug's site met his expectations, "People are finding me."

In Doug's new entrepreneurial world, his highly refined skill in preparing project proposals was critical to the success of his venture. Doug's new customers were largely unknown, they were located everywhere, and they had no prior working relationship with him. Marketing his entrepreneurial offering to these customers and generating sales dollars constituted an area of unproven skill, and represented a major challenge for Doug.

As a consultant Doug expected to sell the capabilities of Dante™ to high-technology customers in engineering and manufacturing. But, since few in industry had heard about Dante™, Doug knew that it would require some special marketing skills to convince prospective customers of the software's benefits. Doug's style was low-key: he was not an overpowering glib sales promoter who was verbose but really said little of substance. Doug spoke with authority, chose his words carefully, and let every word count. When marketing and selling technical services as a consultant, Doug needed to convince a potential customer that his overall competency and his computer modeling approach to specifically solve their problem would provide the necessary and correct answers, just as he had to with his customers in industry. In this respect, Doug's technical competence garnered sales.

Doug used word-of-mouth referrals among people in the field to spread knowledge about his business enterprise. He had memberships in numerous professional societies. Doug supported DCT at national technical society meetings by presenting various Dante™ analyses. This has provided wide exposure of the technology to the segment of the technical community most likely to have an interest in Dante™. Members of these organizations constituted a major component of Doug's network, and the cornerstone of his marketing plan. Conventional widespread advertising in technical journals and publications, or initiating cold calls to potential companies, have not proven effective in this field.

Doug gathered additional name recognition in his field by attending various ANSYS™ user-group meetings and presenting solutions to various complex problems to new analysts in the field (and their companies). As Doug stated, "My marketing plan is focused primarily on developing leads through people I already know, and, more important, who already know me." These referrals were critical to Doug's success. In this regard, Doug worked hard to get his name and that of NRS Associates in front of people who could use his services.

In addition to pursuing his own leads and opportunities, Doug had a number of contacts in his network whose expertise complemented what he did, and it has already provided an early source of revenue. In one instance the consultant working on a job felt that there was more to the failure of the part than just a heat treatment problem as

suggested by the customer. This consultant felt that there might actually be a design error. The customer agreed to have Doug examine that possibility. Two phone conversations and some e-mail between sites in Connecticut, North Carolina, and Indiana provided the information Doug needed. Doug did all the work from his home office. His analysis confirmed that the design of the part was at fault, and he provided the information needed to make the part sufficiently robust for this application. He needed no face-to-face meetings with the various parties.

If Not on the Links, Try the Slopes

The encouraging leads that Doug received in the replies to his September 10 broadcast e-mail announcement dried up completely, or were at least put on a very firm hold by the events of September 11, and no further leads developed during 2001. The lack of solid business activity in technology-depressed markets led Doug to informally establish "NRS Associates, LLC–North" at the family vacation home in upstate Vermont. With his computer network established, Doug could really work from any location. In the meantime, while waiting for the business climate to improve, he pursued potential leads by telephone or e-mail, and made visits as appropriate.

With time on his hands during the winter of 2001–2002, Doug decided to fulfill a long-time ambition. "I took a job as a ski instructor this winter, partly because it's been a dream of mine to be a ski instructor ever since I was 10! I finally got my skiing up to a level where it made sense." However, 70 days of skiing and instructing in early 2002 were not spent passing time and having fun.

The ski slope actually managed to generate a number of promising leads in early 2002. His most promising lead came from private ski lessons he provided to an 11-year-old girl over the 2002 President's Week. On the ski lift, he learned that the girl's father was a high-level engineering manager at a firm to which Doug wanted to sell Dante™. Doug met the father of the girl after the ski lesson and arranged to speak to him at his company at a later date. "He was the boss of all the people that I've been trying to figure out who they are so that I can go try to sell Dante™ to them!" Doug had left no snowflake unturned when it came to developing new leads for any of his analytical consulting services.

Quartz Resonators – A Premium ANSYS™ Analysis

A second unexpected source of leads came through the Internet, reminding Doug of the interconnectivity of websites. Much to his surprise, Doug recently had a telephone call from Dan, a colleague from his university days. Dan was surfing the web and came across Doug's name, and gave him a call.

While a research associate at Rensselaer, Doug studied the mechanics of quartz resonators. Quartz resonators were used in the electronics industry for both civilian and military applications. Doug published three papers based on this research, coauthored with the professor in charge of this research. Dan was still working in the field and brought Doug up to date about the significant advances taking place in the field. He informed Doug that his early papers on quartz resonators were some of the seminal papers in the field, and that anybody working in the field today still knew the name "Shick." Even though ANSYS™ was the software code used to solve quartz resonator problems, the solution required considerable knowledge beyond routine structural analysis. This would enable Doug to charge a premium rate for this class of analysis as well.

Late Spring 2002

With the 2001–2002 ski season over, Doug was spending more time in his office. He had imposed a sense of urgency on himself. He says, "At the moment, all I have to do now is get more work, and that is becoming more urgent. Once I have a job, clients will impose urgency. Typically I'll give a promise date. I've gotten pretty good at meeting those dates over the past few years. Learned my lesson years ago! In the meantime, I've never been happier. Except for the revenues, its great, best thing I've ever done!"

Doug saw incipient signs of the business climate improving, so there should be more positive market opportunities developing for his high-technology computer analysis services. He was following up with earlier leads again in the hope of opening up these opportunities. Promoting Dante™ to organizations that did not know they needed Dante™ continued to be an important next step, as was researching the companies that were active in the quartz resonator field. Doug planned to capitalize on his name recognition in the quartz resonator technical community. These both involved premium-level analyses and would go far in establishing a unique specialty for Doug's business enterprise. A competing firm could not easily replicate these specialized analyses, which could also generate leads for the routine ANSYS™ structural analyses that Doug still felt would represent the majority of his business. Doug was strongly motivated to market his capabilities and to make his new business enterprise work. He believed strongly that he had the talent to make it work, and will leave no snowflake unturned to find that work, reminding himself, "Now all I need is just a bit of good luck."

Epilogue

There was a lot more snow in the mountains and on the ski slopes of upstate Vermont in the winter of 2002–2003 than

in the previous winter, but Doug was doing less skiing. Doug's business was in the black, and in his words, he was "off life support!"

Questions for Discussion

1. For most of his career Doug had few thoughts about being an entrepreneur, but now he embraces his new role enthusiastically. Which aspects of Doug's personality appear to be helpful for his potential success as an entrepreneur? Which aspects could be a hindrance?
2. Doug has accumulated a number of skills from his past employment opportunities. Which of these skills contribute to his success? What skills may he be lacking? If so, how can he overcome this deficiency?
3. In many ways Doug is just another consultant who advertises his services through the web and via his network. His offering, however, has two unique services—Dante's™ distortion prediction and ANSYS's™ quartz resonator analysis. How best can he capitalize on these?
4. What start-up activities did Doug initiate to establish his new business enterprise?
5. Innovations can be considered to come in two broad classes: incremental and radical. Where would you slot Dante™? Are there potential benefits to being in one class or the other?
6. What characteristics define intrapreneurship and entrepreneurship? Distinguish between them.
7. Doug admits that his current revenues are not in line with his original business plan. To what extent do you think this is a direct result of the unexpected events of September 11? Suggest how he might go about revising his plan after September 11, and deciding if and when he should seriously consider abandoning his own business and explore other options.
8. Doug's IT experience enabled him to establish a professional website at minimum cost. Visit his site (www.nrsassoc.com), and review how Doug gives the impression that he has a larger operation than a single-person enterprise. In your opinion, is this deceit ethical, or even good business? Give your reasons.
9. Although Doug meticulously thought through all aspects of his business before start-up, events did not go according to plan. Now he recognizes that he could use some help jump-starting his business in a technologically depressed economy. What advice do you have for Doug at this point in time?
10. Is Doug's technical expertise sufficient?

Endnote

1. Teaching notes are available upon request from the author at WoodillaJE@sacredheart.edu.

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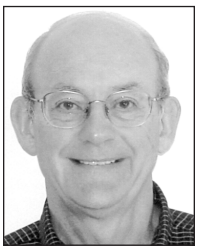

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Woodilla remains active as an industrial member on the Materials Academic Advisory Board of the Department of Metallurgy and Materials Engineering at the University of Connecticut. He is education chair of the Hartford Chapter of the American Society of Materials.