Innovation and Entrepreneurship

Dental Industry and Academia Unite to Foster Product Development

New products don't simply appear in the dental office. New products begin life as an idea, which first must be captured so that with creativity, energy, time, and money it will be patented and become an "invention." However, this is only the beginning. To become a product, the invention must traverse a path that is not clearly marked and where obstacles can stall its progress at every step along the way. The slow rate of introduction of new products to the dental profession suggests that the existing process for new product development needs improvement. The research to improve the process must begin at the start of the process—the idea stage. Who has the ideas, how to improve their capture, and how to encourage their conversion to inventions need to be examined. Next, research on how to transform the invention to a product is necessary. Generally, licensing, obtaining venture capital, prototype development, and obtaining regulatory approval are involved. Finally, it is crucial for the next generation of dental academics and practioners to have knowledge, experience, and skills on how to generate the new ideas and incorporate them as new products into their practice.

It follows that dental school curricula should include courses in new product development and encourage dental students to participate in the research into these areas. I predict that dental school graduates who receive education and research experience in new product development will be more likely to contribute ideas for new products. They also will be more likely to accept new products into their practices. As a result, the rate of new product development will accelerate.

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The Origins of Ideas

Ideas for new services, technologies, equipment, and products are generated in academic and industrial research laboratories and in dental offices. The fate of the idea, however, depends on where it occurs. When an industrial scientist has an idea, it usually survives because it is handed off to others in the company with expertise in the product development process. In contrast, when an idea occurs to an academic scientist, it can be lost because most dental schools do not have financial resources or staffing to provide the needed expertise to the dental faculty. Therefore, the fate of the idea depends on the scientist's knowledge of the product development process. If the scientist has experience or has colleagues with experience, the idea might survive and become a patent. When ideas occur to dentists in private practice, the idea rarely survives. It would be unusual for a practicing

Conference on Integrating Biotechnology With Clinical Dentistry

A number of my readers have sent me e-mail messages requesting a progress report on the development of biotechnology-based products for the dental profession and an update on the time frame for the introduction of these products into clinical practice. In response to these requests, the Planning Committee of the 2005 American Biodontics Society (ABS) annual conference has recommended the following session topics: caries and periodontal vaccines, bioscafolds, stem cells for growing teeth, and calcium-phosphate restorative materials. If you are interested in learning more about the ABS annual meeting, as well as requesting registration materials, or if you would like to suggest other topics to the Program Committee, please send me an e-mail message at erossoma@nso2.uchc.edu.

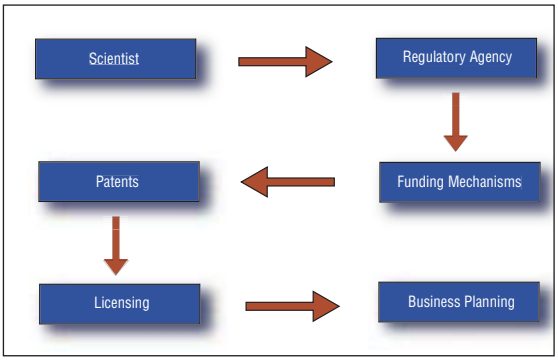

Figure 1—Representation of the product pipeline. The scientist begins the flow by entering the invention into the pipeline. Following the arrows, the invention flows through the pipeline passing through each of the stages represented by the blue boxes.

dentist to have any knowledge of the product development process, as well as the time, money, or energy to pursue the idea to the patent stage. So the dentists "ask around" or go to the Internet. As a result, many good ideas conceived by dentists are lost. Clearly, to accelerate new product development, the process of capturing the ideas of dental academics and private practitioners needs improvement.

The Product Pipeline

When ideas are patented, the new invention must traverse a path that is not very clearly marked to become a product. In addition to the unclearly marked path, a variety of barriers appear, impeding progress. The path from idea to product is not straight; it has numerous forks, and selecting the wrong fork can lead the invention to a dead end. A pipeline is a useful metaphor for this pathway; if we follow the pathway within the pipeline, we will encounter the stages through which the invention passes on its way to becoming a product—licensing; business plan development; funding; and prototype construction, manufacturing, and marketing stages. Successful passage through each stage requires effective personnel interaction. For example, the scientist must explain the idea to the patent attorney, the venture capitalists, and others with interactions between manufacturers and marketers, and finally, the interaction between the salesman and the dentist must be successful. Each person in the sequence has different goals and expectations for the invention/product, and the success of the interaction depends on the ability of each to understand the goals of the other and to reach a compromise. The stages and the pathway that the invention will follow are shown schematically in Figure 1.

To provide an example, we follow the new product, amorphous calcium phosphate (ACP), which was introduced to market in 2004 through the product pipeline.[1] ACP traces its origins to basic research that began in the 1960s and continued to the mid-1990s. When a patent was filed in the mid-1990s, ACP's basic research phase concluded, and the invention's passage through the product pipeline began. Within the pipeline, 2 steps occurred: The patented invention was licensed, and a prototype was developed (F Eichmiller, DDS, written communication, March 2004). In 2002, the Harry J Bosworth Company continued the product's development, and 2 additional years were required to complete the next 2 steps—scaling up for production and preparing the product for market (M Goldstein, President of the Harry J Bosworth Company, oral communication, April 2004). The question is why it took ACP almost 10 years to flow through the pipeline and what needs to happen to accelerate this process.

First, it is necessary to study each step in the pathway, identifying issues and problems that might impede the progress of the invention through the pipeline. Research of this type usually is carried out in business schools where product development is taught by the case study method. However, most cases involve industries such as automobiles, airlines, computers, or telecommunications. Sometimes health industry cases are used, but they usually involve the insurance industry or the companies that deliver health care. Only under special circumstances would a case from the dental industry be considered, but it would be surprising if the case involved a dental scientist or practicing dentist attempting to develop an idea into a product. Clearly, the teaching of such cases to dental faculty and dental students (the future dental practitioners) could only help them to move effectively through the new product development process.

Translational Research

Because the issues and problems associated with bringing new dental products to market are unique, these case studies should be taught in dental schools. Dental students also should

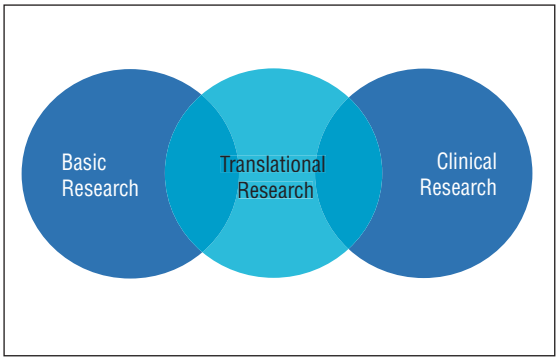

Figure 2—The circles represent the 3 areas of research. Each circle encloses the courses and information taught with the curriculum for each of the research areas. The shaded or overlapping sections of the circle illustrate that the translational research curriculum would include courses and topics for both the basic and clinical research curricula.

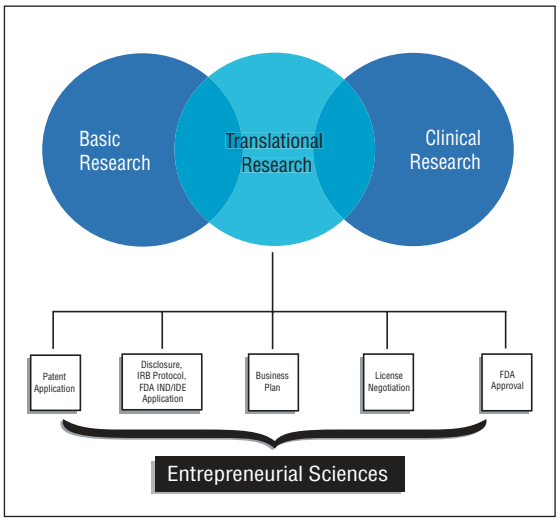

Figure 3—The translational research curriculum is expanded to include the entrepreneurial sciences. The boxes list some of the specific courses and topics in the translational research curriculum.

be encouraged to participate in research studies on the events that influence flow in the pipeline. Translational research (TR) seeks to understand the processes that transform an invention into a dental product. TR differs from both basic research, the goal of which is to discover the laws guiding biological and physical process, and clinical research, the goal of which is to determine efficacy and safety of new products already manufactured through clinical trials. However, TR requires knowledge of both basic and clinical research; thus any curriculum to teach TR would include both (Figure 2). For example, the TR curriculum should contain courses in molecular biology and genetics, as well as courses, such as epidemiology and statistics, needed for clinical trials' research.

Without including courses in entrepreneurship and the study of cases in the development of dental products, a curriculum in TR scarcely would accelerate the process of new product development. Figure 3 illustrates how the entrepreneurial sciences fit into the TR curriculum. A TR curriculum containing selected courses from the basic and clinical sciences connected by courses in the entrepreneurial sciences would provide the idea people (ie, the dental students and dental faculty) with the expertise necessary to move the idea from the basic science laboratory to the clinical trials stage.

Pilot Studies on Capturing Ideas

The primary goal is to capture more of the ideas generated in the dental academic laboratory and dental office to ensure a flow of inventions into the product pipeline and of new products out of the pipeline and into the dental office. One approach to minimizing the loss of new ideas emerged from a report published in 1999. The National Institute of Dental and Craniofacial Research (NIDCR), concerned about the flow of new products and technologies, as well as the decline in the number of dental faculty members, published a report; it recommended that the education and training of future dental academic scientists include courses on technology transfer, management, and entrepreneurship.[2] However, introducing changes to any institutional culture, specifically the dental academic culture, takes time and requires convincing committees and administrators that the change will benefit the existing program. Therefore, such federal recommendations usually are accompanied by funds for pilot studies. If these preliminary data suggest that the change is warranted, the academic committees and administrators are more likely to entertain plans for changes.

In 2003, NIDCR funded a pilot study to determine whether courses in management, entrepreneurship, and technology transfer would be helpful to dental students, residents, and faculty of the dental school community interested in transforming their ideas into product. As part of this study, a one and one-half day workshop was developed and offered on a voluntary basis. The program offered lectures regarding entrepreneurship, as well as a case study involving the issues faced by a den-

Table 1—Members and Affiliations of the Industry Advisory Council for the Center for Research and Education in Technology Evaluation

Name	Affiliation
Mr. Carl Bretko, Chair	President and Chief Executive Officer—Dental EZ Group
Mr. Brian Watson	Sr Vice President—Sullivan Schein
Mr. Gary Johnson	Vice President, Sales—Patterson Dental
Mr. Grant Gerke	Vice President, Sales—ADEC
Ms. Mildred Goldstein	President—Harry J Bosworth Company
Dr. Ralph Green	Executive Vice President—Reach Out Healthcare America
Mr. William P Dragan	Vice President and General Manager—Centrix Incorporated
Mr. Gordon Hagler	Vice President and General Manager—Trophy Dental
Mr. Alan Kegerise	Sales Manager—Premier Dental Products
Dr. George Tyswosky	Vice President of Technology Development—Ivoclar Vivadent, Inc

tal school professor who transformed an idea into a product. The program first was presented at the University of Connecticut School of Dental Medicine, and those who participated either were involved in the development of an idea (the faculty) or had an interest in learning about how ideas became products (the students and residents).

The results of a postworkshop survey indicate that the faculty thought the courses presented in the program would be helpful to the commercialization of their ideas, and the students and residents expressed the view that the program would be applicable to ideas that might emerge during their practice. Many of the dental students who had worked in basic research laboratories before the workshop expressed an interest in continuing to do research but in an area or on a topic that would lead to the development of a product that immediately could be applied in dental practice. This finding is important because many dental school graduates usually express no interest in basic or clinical research or in entering academic careers after graduation. This lack of interest in academic careers throughout the past several decades has resulted in an alarming number of unfilled full-time faculty positions in US dental schools.[3] In contrast, the dental students who participated in the pilot study indicate that pursuing research and an academic career might be more appealing if their research were product oriented (ie, if they could conduct translational research).

A Role for the Dental Industry to Promote Entrepreneurship in Dental Schools

A continuous supply of new ideas is critical for the product pipeline to yield new products, which are necessary for the growth of dental industries. Because new ideas come from the dental academic scientists and practicing dentists, the dental industry should be interested in developing programs to capture these ideas and to enhance their passage within the discovery pipeline. Supporting translational research and the introduction of the entrepreneurial sciences into dental school curricula should be a priority of dental industry leaders.

At the University of Connecticut's School of Dental Medicine, the Center for Research and Education in Technology Evaluation (CRETE) has assembled a group of distinguished representatives from the dental industry to provide guidance and advice for this purpose. The members of CRETE's Industry Advisory Council (IAC), listed in Table 1, have been asked to assist in the development of an educational program and a research laboratory where dental students, residents, and faculty can learn and investigate the transformations that occur in the discovery pipeline. The purpose of the new research laboratory is to provide an environment in which dental students and faculty can learn the fundamentals of the entrepreneurial sciences and, therefore, be better equipped to capture new ideas. In this way, the dental academic community, working together with the dental industry, can accelerate the introduction of ideas into the product pipeline and accelerate their flow into

the dental office. The IAC provides a unique opportunity for the dental industry to become involved in the support of research that will directly affect the industry, as well as the development of products to improve the oral health of people worldwide.

Acknowledgments

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