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The academics and technology transfer

A recent article in *Science* magazine called attention to the oversimplified belief that research inevitably leads to innovation. Reporting on statements by Stanford economist Nathan Rosenberg and mechanical engineer Stephen Kline, the article points out that "both engineering and theory in a repetitive testing of ideas" are essential for the creative process to lead to adaptation.

This philosophy has been the underpinning of the agricultural research and extension continuum that developed from the Land-Grant, Hatch, and Smith-Lever Acts of the late 19th and early 20th centuries. It is fundamental to the agricultural research, extension, and teaching system that there be a constant interaction of ideas and repetitive testing of concepts until knowledge becomes technology and technology becomes adaptation and an innovation is ready for use by society.

Observers are often confused by this process. They seem to assume that the agricultural scientist simply hands newly developed knowledge to the extension specialist for application. In fact, some of our land-grant universities do not understand this concept and strive to keep research and extension personnel separate. This separation, of course, is contrary to the basic tenet of the process of converting research to innovation. As Rosenberg and Kline point out, substantial interaction is essential if the creative process is to lead to adaptation.

Historically this process has worked quite well in the United States, where biologists have interacted with agriculturists and medical scientists, and where physicists and mathematicians have interacted with engineers to bring innovations to our society at a rate that some would contend exceeds our ability to evaluate the appropriateness of such innovations. That is the historical situation. This country's economy depends on a continual level of development to compete with such high-tech nations as Japan, other Pacific Rim countries, and European nations. State and federal governments are increasingly concerned that technology transfer move as efficiently and effectively as possible to keep us at the forefront of science and to maintain our economic position in the world.

The university faculty scientist is a key component in this system. It is this person who has trained future scientists, developed the knowledge essential for technology, and interacted with the engineer or extension specialist to bring about innovations. The success of the process has been due in part to the fact that these scientists understood the need for inno-

vation and believed their participation was an essential component of the interactive process. I believe our university faculty scientists today still have those concerns and beliefs, but I am concerned that other forces may be limiting their ability to take part in essential "repetitive testing."

Today's faculty scientist must be a teacher, researcher, grant-writer, personnel manager, business manager, entrepreneur, consultant, governmental advisor, committee participant, judicial witness, and public speaker. It also helps to be able to design and build equipment, laboratories, and special facilities unless one has the luxury of time to wait for the system to provide them. The point is that university infrastructures are often found wanting. Outdated equipment and facilities and inadequate funding within the university to support a research program make it necessary for the scientist to help raise money to carry out research programs, to procure equipment, and to build facilities.

The grant process can be a never-ending cycle of two-year applications to multiple agencies. Classes must be met and a strong publication record in refereed journals must be maintained to keep the grants coming and to meet the requirements of the academic process for advancement and promotion. What can be set aside? In some instances, it may be the interaction so essential for adaptation of knowledge.

Too often faculty members tell me they would like to be more involved in applied or interactive work, but there simply isn't time or they don't get academic credit for the work.

In the pursuit of academic excellence, we may have established a system that rewards our scientists for the development of knowledge but may penalize them for adapting that knowledge to a usable form.

Many of the demands on researchers are set to ensure and reward excellence, and that goal cannot be questioned. Nothing is more expensive than an incompetent scientist. It is not unreasonable to ask, however, if all of the demands really result in the excellence we desire in the ways in which it is desired. Does pressure to excel result in a productive career over 30 to 40 years, or is early burnout a problem? Does it result in a quality teaching program that will ensure future scientists and citizens? Does it allow for application of the scientific knowledge being developed?

The fundamental question is, What are our goals for our academic scientists? Is it time for the economic and academic communities to evaluate our objectives to ensure scientific excellence in our faculty as well as our students, our citizens, our economy, and our government?