Drying Technology
An International Journal

ISSN: 0737-3937 (Print) 1532-2300 (Online) Journal homepage: http://www.tandfonline.com/loi/ldrt20

Editorial: R&D: A Historical Perspective

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To cite this article: Arun S. Mujumdar (2013) Editorial: R&D: A Historical Perspective, Drying Technology, 31:11, 1191-1191, DOI: 10.1080/07373937.2013.812768

To link to this article: https://doi.org/10.1080/07373937.2013.812768

Published online: 25 Aug 2013.

Drying Technology, 31: 1191, 2013

ISSN: 0737-3937 print/1532-2300 online
DOI: 10.1080/07373937.2013.812768

Taylor & Francis
Taylor & Francis Group

Editorial: R&D: A Historical Perspective

Keywords Einstein; Max Planck; R&D; Willard Gibbs

Bill Bryson's *A Short History of Nearly Everything*[1] makes for a truly fascinating reading. The chapter on Einstein's Universe is particularly enthralling for anyone with the slightest interest in science. As Bryson noted, by the end of the 19th century scientists appeared to have discovered almost all of the mysteries of the physical world, from electricity and magnetism to optics and radioactivity. Many wise people of the day believed that there was nothing much left for science to do, to quote Bryson. In fact, in 1875 when Max Planck was deciding between physics and mathematics to make his career in, he was advised to avoid physics as "the breakthroughs have already been made." Fortunately, he did not listen and the rest is history. In 1891 he produced new results on entropy, or so he thought, until he discovered that Willard Gibbs, a professor at Yale, had already done work on entropy and published it in a rather obscure journal of the Connecticut Academy of Science and Arts. Max Planck moved to other areas, which turned out to be a good thing; he produced his celebrated quantum theory, which is a landmark contribution to the modern science.

The history of science and technology is replete with examples of declarations by famous wise men of science and technology that there was nothing more truly worthwhile remaining to be done in their areas. History has also shown this to be consistently wrong. Over 100 years ago the commissioner of the U.S. Patent Office recommended to the then president of the United States to close the Patent Office "as everything that could be invented has been invented." Clearly, the proliferation of patents from all over the world is a testimonial to the fallacy of this prophecy. Crystal gazers of today also need to foresee the future to select and fund research areas that will be significantly important in the future. We can only hope that their vision and forecast are at least as good as those of our friendly weathermen.

Clearly, there is still potential for new discoveries and inventions and hence the need to support R&D at all levels and in diverse fields. We do not know in advance which one of the projects will bear fruit and will make a lasting economic and social impact. Although we know that research involves risk and that only a small fraction of R&D projects will ultimately yield positive outcomes, one does not know in advance which ones will succeed and hence the need to fund many more projects than perhaps seems necessary.

Dissemination of peer-reviewed results of research is an important part of R&D. It is a much lower cost effort compared to the cost of generating R&D output. Research outcomes are available at low or no cost with the advent of the worldwide web and advances in telecommunications technology. Thoughknowledge can be accessed free of cost in many cases the utilization of such knowledge for the benefit of industry, business, or societal good is not "free." It requires talent that is able to access and assess and articulate this knowledge into a usable form. This step is not free and hence only "the prepared societies" can benefit from it. Advanced education in science and technology is needed to enhance the accessibility and ability to convert the knowledge into useful products and processes. Human capital outranks financial capital in today's high technology world. We need to develop "wisdom-based" policies and optimize resources by sharing them collaboratively rather than competitively. This will avoid unnecessary duplication of R&D effort and utilize global resources fruitfully for maximal impact. Intellectual monopoly may make short-term gains for those who practice it, but in the long run this will turn out to be an ineffective myopic policy.

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