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Tell us your Lab-to-Fabulous story

The process of technology translation that brings innovations created in a laboratory to marketable technologies needs to be aided by scientific publishing that highlight real-life research-to-market experiences.

The application of engineering solutions to societal challenges relies on continuous technology innovation, which requires the co-creation of knowledge by the collaboration between universities, institutions, private research centres and industries. The data show that the competitiveness of different countries and regions correlate strongly with the extent of industry involvement with academic research[1]. This prompts the question of how to translate research and development into actual manufacturable products. In other words, how to reduce the barriers to commercializing scientific ideas with strong application potential and go from small-scale laboratory demonstrations to marketable technologies. And, finally, how scientific publishing can help to facilitate this process.

In the semiconductor industry, for example, technology translation is known as the 'lab-to-fab' translation, in which 'lab' refers to small-scale laboratory settings such as university laboratories, and 'fab' stands for semiconductor manufacturing plants. Building and running a fab is an economically costly and technologically complex undertaking that requires strict manufacturing standards by a highly skilled workforce. This is why, no matter how elegant a lab solution may seem, its transition to a high-volume manufacturing setting is not always warranted and rarely successful. The lack of at-scale demonstrations is a consequence of labs being unable to produce high-performance chips large enough to convince the industry to invest in, let alone adopt, these emerging technological concepts in their manufacturing practices.

Considering the high strategic importance of chip manufacturing, the lab-to-fab translation has become a matter of national security. To bridge the gap and shorten the time to market, many countries perceive the development of national research and development infrastructure as a means of revamping their semiconductor ecosystems by accelerating the transfer of technology. For example, according to the recommendations prescribed by several chip initiatives across the world such as the US CHIPS and Science Act and the European Chips Act, securing the semiconductor supply chain and ensuring technological leadership would necessitate a considerable investment in connecting the industry, research, design and testing capacities for seamless translation of next-generation technologies.

> "Scientific publishing [can promote] technological innovation through the dissemination of ideas and the assessment of their commercial potential."

The lab-to-fab conundrum is by no means unique or limited to the semiconductor industry. Whatever the technology, when it comes to bringing lab-scale ideas to market, the same crucial points need to be addressed such as early-stage funding, connection to market, securing test-bed facilities, rapid certification, manufacturing, supply chains, documentation and standards. Moreover, regardless of the chosen commercialization path, new knowledge originating from academic research must be created, tested, reported and recognized as marketable. This is precisely where scientific publishing becomes instrumental in promoting technological innovation through the dissemination of ideas and the assessment of their commercial potential – for example, by prototyping in start-ups or industries. Admittedly, technological promises outlined in research papers are often speculative and the reported concepts are too premature for validation at large scale. In addition, it is extremely hard to track the progress of these innovations over time as, although they may be expanded through further research, patented or picked up by start-ups or companies, publishers have no real practical tools to monitor knowledge-to-market transformation. What scientific journals can do, however, is aid in uncovering and highlighting successful technology translation examples as well as failed attempts, as both can serve as valuable lessons of what works in practice and how to avoid common lab-to-fab pitfalls.

From this issue onward, *Nature Reviews Electrical Engineering* will regularly publish short 'Lab-to-Fab' articles written by experts in electrical engineering describing their first-hand experience of technology transfer. Lab-to-Fab articles will include some aspects of technology transfer such as intellectual property, regulatory considerations, scale-up, collaborations with industry, manufacturing and application. In addition, we hope that Lab-to-Fab articles will prove useful in outlining a variety of scientific and technical challenges in the process of technology transfer.

In this issue, we present our readers with four Lab-to-Fab articles. In the first piece, Peng Liu from Tsinghua University discusses how his team's two-decade-long work on super-aligned carbon nanotubes resulted in the development of field emitters that were successfully adopted in the neutralizer for the Taiji-1 satellite project. Another Lab-to-Fab from Soon Aik Chew et al. reports on the recent progress made by IMEC in wafer-to-wafer hybrid bonding, a promising 3D integration technology, that yields interconnect pitches down to 400 nm. Going from electronics to medical technology, in our third Lab-to-Fab, the founders of the INBRAIN Neuroelectronics start-up describe the challenges of the journey for graphene-based neural interfaces. Finally, in our fourth Lab-to-Fab, we encourage interested readers to learn about the successful

implementation of a mid-infrared photonic sensing platform for monitoring methane emissions, developed by a team at the University of Oklahoma for applications in the oil and gas industry. We hope that the community will find these real-life examples of technology transfer useful and inspiring. Although the challenges of moving from a laboratory concept to market are multi-faceted and case specific, it is our role as a scientific journal to contribute to the process of successful technology transfer by sharing these stories and the valuable lessons they teach us.

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