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Effective Technology Transfers in Academia

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Abstract

A successful technology transfer of scientific research results obtained in academia to a commercial product or service is a rare occurrence. It is even rarer for an institution in a developing region. At HKUST, I was fortunate to be a participant on two occasions, and maybe a third one. One relates to the so-called PRS in educational technology that provides immediate feedback and reinforcement for active learning in a large class. Another, in biotechnology, concerns the applications of human growth factors (*hEGF* and *bFGF*) produced by a proprietary bacteria excretion system (*BES*). The affordability and authenticity of this *hEGF* enabled, for the first time anywhere, the treatment of diabetic foot ulcers with 95% success and other hard-to-heal wounds like bedsores and Steven-Johnson Syndrome with equal effectiveness. The third relates to the new use of human resources --- enlist a group of already successful individuals to live together in fellowships in a resort environment and to actively assist in the educational, economic and social development of the host locality. A review of these developments may provide clues for increasing the occurrence of these and other similar desirable outcomes.

Introduction

Knowledge derived from research and development (R&D) drives healthy societal growth as is evidenced by the data on Gross Domestic Products (GDP). Most R&D is conducted in universities. Universities are ranked according to the quality of their research output, the major element of which consists of the publications of their faculty. The rank order then is based on a figure of merit that takes into account the number

of publications and the so-called impact factors of these papers. The impact factors are discipline specific, and are determined by the leading academics of the respective disciplines. It is not surprising then that technology transfer of research result that fills a niche or is breakthrough in application is a rare occurrence because of the nature of the incentive just mentioned. Of course contract research with established industry is common in professional schools but it is directed mainly at processes, systems, or technologies already in place. Such contract research is also rare in a developing region for economic reasons.

Societal growth cannot depend on services alone. New products and goods, including tools for services, are essential and these require technology transfers from R&D. There is a recent unhealthy trend of the better students gravitating towards the business schools for their first degree. This trend could be made more balanced by not only accomplishing more successes with technology transfers in academia but also, when making personnel decision, by weighing equally the impact factors of technology transferred to the market place and those of academic publications.

Here we focus on the "new or broad impact" type of technology transfer. The fact that it occurs rarely does not mean that there are no common threads among successful cases. It is my hope that these common threads be identified from recounting my own experiences so that (1) the powers-that-be could incorporate these in their plans, budgets, and operations and (2) the chance of success for technology transfer in academic is increased.

PRS - An Educational Technology Transfer

Few would argue against *Socratic dialogue* as the best way to teach because the two-way communication provides immediate feedback and reinforcement to both the student and teacher. Feedback is important to students since learning requires inspiration, motivation, reinforcement or a combination of these and, in the classroom, it enables the learning to be supplemented by *peer instruction* among students and contingency teaching wherein the coverage is geared to responses from students. But *Socratic dialogue* is impractical for a large class and, so, a learning tool called the *Personal Response System (PRS)* was developed [1, 2, 3] to enable the essential aspects of *Socratic dialogue* in the classroom.

PRS enables each and every student to answer questions in private in a large class. It is based on the mature infrared technology similar to that of the remote controller for TV and, therefore, is relatively low-cost and reliable. Its features include (1) student transmitter handsets each tagged with a unique ID that permits individual ownership, (2) the handset having a 10-digit keypad plus two additional H/L modifier keys for indicating high or low confidence on the answer sent, and (3) the answer is accompanied

by the ID. The signals are registered in a line-of-sight receiver connected to a PC. A larger area can be covered with several receivers connected in series ahead of the PC. The teacher poses a multiple-choice question by any convenient means. The students respond by pressing their answer on their handset within the pre-set time interval (a minute or two is usually sufficient for a class of 100). The successful reception of each signal is acknowledged by a flashing box in an array projected on the screen that shows the corresponding ID. At the end of the question interval, the individual responses are recorded in the PC and the tabulated results are displayed as a bar-graph for immediate feedback.

The experiences of diverse PRS users have been positive. For example, Draper and Brown of Glasgow [4] surveyed several disciplines and concluded that the use of the handsets was judged by both learners and teachers to benefit them. The three most important features reported by students were (a) getting feedback to learners about whether they understand the material presented, (b) it does get most students to think about the question and decide on an answer while alternatives do not, and (c) the anonymity is often important in achieving these benefits. Perhaps the best testimonial for the success of the technology transfer is the numerous PRS users listed on the Internet that span across disciplines, institutions, and continents.

Specific to *PRS*, the sequence was:

1. the need to engage all students for active learning in a large class was recognized;
2. the solution implemented was a learning tool based on a low-cost existing technology and developed by a team with one member having expertise in microelectronics;
3. a prototype was built to prove the practicability of the conception;
4. intellectual protection (IP) was filed;
5. the IP was licensed to an OEM (original equipment manufacturer);
6. the OEM proceeded with the production only when there was a guaranteed number of units ordered that covered the start-up cost (fortunately, the author had a teaching development grant that can be used for the purpose); and
7. the products were distributed mainly through word-by-mouth and the Internet.

Recently, an extension of the technology that would make it accessible even to the economically poorer areas was worked out and the IP protection filed [5].

GVN - A Biotechnology Transfer

With the 21st Century belonging to Biotech just as the 20th Century belonged to InfoTech, I was determined not to be left out. Thus, when Wan Keung Wong of Biochemistry at HKUST asked me to join the technology transfer efforts of the Bacteria Excretion System (BES) he developed in Escherichia coli and Bacillus subtilis, I did not hesitate to jump at the opportunity

In BES, the recombinant proteins are excreted into the medium and, thus, enabling purification that is simple and straight forward. Over 10 recombinant proteins of different origins, functions and sizes have been produced. The most notable of these is human epidermal growth factor (hEGF). The hEGF so produced has been tested to be pure, authentic, and toxin-free, and indistinguishable from one produced by our own body. Its cost effective production has enabled, for the first time anywhere, the treatment of diabetic foot ulcers with 95% success [6] using our hEGF. The successful treatments of other hard-to-heal wounds like those of bedsore and the Steven Johnson Syndrome have been equally dramatic [7].The large scale production of basic fibroblast growth factor (hbFGF) is now being developed. The combination of hEGF and hbFGF would provide a significantly more effective treatment of deeper wounds.

The successes with hEGF should have easily attracted licensees or investors particularly with a patent on hEGF filed [8], but that was not the case. After some period and many efforts, an injection of venture capital by the China Nansha Technology Enterprises Limited has provided impetus with the formation of a company called Gene-vinate Limited (GVN) [9]. GVN utilizes the results of biological research and development for the active promotion of skincare and healthcare technologies and products. Its activities include the production of human growth factors and the development, production, and marketing of cosmetic, skincare, and healthcare products with various combinations of hEGF and hbFGF as active ingredients. The first consumer product is now in the market.

Success had not come easy perhaps because the technology was "too new" for its time. The original partnership had to shoulder all expenses associated with the patent application and bFGF production development as no other party was willing to do so.

SHARPEN - A New Social Institution

In the undertakings discussed above, three stages can clearly be delineated.

1. A new marketable idea or concept that came serendipitously, through experience, a systematic study, or a combination of these. Exchanges of ideas with various experts would clearly be helpful in this context.

2. Demonstrate the practicality of the idea or concept. A working prototype is essential, and accessible and affordable resources, both human and material, are required.
3. Implement and market the product or service. A working capital is needed and a good network for this is almost essential.

A common denominator for all three is accessible expertise that is affordable. In academia, it is almost always necessary to go outside of the institution for such resources at some stage. A natural question is — why not have most, if not all, of the expertise in house? There is also the increase chance of generating a useful idea or finding a creative solution to problem when the working group consists of experts in various areas coming from different backgrounds. A new organization called the Society for the Housing and Advancement of Returned Professionals, Educators, and Networkers (SHARPEN) is being formed partly in response to this question.

There is a personal angle to SHARPEN [10] as well. Since it is not uncommon for successful people to purchase a housing unit in a resort here and there for vacation and/or retirement, why not do it together with people of similar inclinations in the same location so that one could continue to be active by helping the local community grow while enjoying a life of leisure and fellowships? Members could enjoy:

1. a well-equipped housing facility;
2. belonging to a unique organization;
3. doing teaching, technology transfers, starting new businesses and/or incubating high-end industries;
4. belonging to a critical mass of experienced professionals to undertake inter-disciplinary, multi-disciplinary, and think-tank activities;
5. an opportunity to develop symbiotic relationship with the community;
6. an opportunity to have a profound positive impact on society that one could not achieved individually;
7. a natural setting to interact with young people; and
8. living and working in fellowship with a group of like-minded, stimulating people with different backgrounds.

The suggested qualifications of members are:

1. experienced teachers;
2. established professionals;
3. senior civil servants;
4. researchers with good track record in R&D;
5. experienced managers in large organizations; and
6. successful entrepreneurs.

The host locality could benefit from:

1. a pool of seasoned experts and professionals with international experiences and networks to assist with its developments;
2. in-house expertise on education, applied research and technology transfers (starting new project/program quicker);
3. continuous replenishment with new bloods;
4. a large capital injection because SHARPEN members purchase their own housing and pay living expenses;
5. added cultural and economic values and activities;
6. good chances of being bequeathed with wealth;
7. more likelihood of outside injections of capitals and development funds;
8. experts coming voluntarily that the locality could not attract nor afford to pay under other circumstances.

Potential members are all over the world. For SHARPEN/China, there are the Chinese intellectuals and scholars who left Asia in the 50's to 60's because of political turmoil. Their Chinese roots and upbringings would beckon them to return "home". For SHARPEN/Philippines, there are the many Filipino intellectuals and professionals all over the world who left for economic reasons. Returning home could be attractive particularly if they feel that they are useful and wanted. It may just be the impetus that would enable the establishment of a world-class university that, in turn, would make Philippines a regional center for higher education. Two other points to note are: (1) non-retirees are not excluded provided they are willing to be a resident for an extended period each year, for example, three months; and (2) the summer for Northerners is the beginning of the academic year in the Philippines.

Quo Vadis?

In discussing PRS and GVN above, the three stages leading to success all require expertise. One invariably needs to go outside the institution to obtain some of these. It is reasonable to expect an increase chance of success with technology transfer if all or nearly all resources are available in house. In academia, there is also the need to give the appropriate incentive of weighing the merits of technology transfers as no less than those of publications in refereed journals. SHARPEN is suggested to be an alternative solution for in-house resources. In a sense, SHARPEN could be considered a technology transfer in itself if and when it becomes operational. Already mentioned is the increase chance of generating a useful idea or finding a creative solution to problem when the working group is composed of experts in various areas coming from different backgrounds.

More successful examples would also serve to encourage others. Other technology transfers that I have been involved with include: (i) the HKUST College of Lifelong Learning that relied heavily on the Internet to deliver instructions which at that time was considered novel, (ii) Creative Forex Limited [9] with Amador Muriel as co-founder for trading foreign currencies based on his new "Molecular Theory of Turbulence", and (iii) Bio-Click Technologies Limited [9] that have the know-how for the BES productions of the three Cellulases (Endo-cellulase. Exo-cellulase, and Cellobiase) needed to convert cellulose into glucose for applications in biofuel and waste recyling. The first two do not quite fit the "new or broad impact" type, while the third has a huge threshold for Stage-2 development which would require signifciant time, effort and resource to surmount. It is nevertheless interesting to note that item (ii) could help SHARPEN grow their reserve funds for projects.

The bottom line for successful technology transfer is having a group of creative, educated, and experienced people working together with a common goal. What is new with SHARPEN is to explicitly sought out those individuals who are already financially self-sufficient, who cherish the joys of fellowships, and who willingly and actively work together to find ways to enhance the educational, economic, and social developments of the host locality or institution.

Finally, a successful science and technology park like those found in Boston and San Francisco is anchored on one prominent R&D-oriented university or two. The least arduous route to achieve a similarly successful park is to first have a group of professionals in-house with various talents and experiences to help nourish a R&D-oriented university along, and SHARPEN is such a group.

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