The prospects of Excellence Initiatives in research

Key Ingredients for a Successful Academic Research Institute

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During the past two decades or so, many countries have started Excellence Initiatives as a mean of reforming classical academic institutions and to enhance their research productivity. Common to these initiatives is the creation of new structures: either new institutes or collaborative networks to strengthen existing research infrastructure and help individual universities to focus on their core strengths. Based on our experience, we here provide a personal perspective on the key ingredients needed to start and maintain successful research institutes. We also highlight the urgent need for governments to think about the long-term perspective for successful institutes, in particular mechanisms to secure funding towards the end of the programs or support a transition to make sure that the financial investment by the government and its founders is not lost.

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Fostering academic excellence

In Germany, the Excellence Initiative laid the ground for blowing fresh air into the centuries-old established German university system (Vogel, 2019). The Excellence Initiative has shaken up the university landscape and has created many new centers of excellence. Japan implemented a similar system: the World Premier International Research Center Initiative (WPI; www.jsp.go.jp/english/e-toplevel/). A unique feature of WPI is its quest to form interdisciplinary institutes with true and passionate collaboration as a key ingredient. WPI has been a major success, and the lessons learned are valuable for other Excellence Initiatives across the world. These and similar projects led to a continuous upspring of new institutes and raise the challenges for creating successful institutes from scratch. Over the past decade, several scientific institutes were founded and became highly productive and successful: HHMI’s Janelia Farm (Rubin & O’Shea, 2019), the Francis Crick Institute in London (Nurse et al., 2013), or the Wyss Institute (Tolikas et al., 2017). The Policy Institute at King’s College London and Rand provided an excellent outsider perspective on the characteristics common to high performing research units (Manville et al., 2015).

As founders and past or present Directors of scientific institutes in the fields of chemistry and biology, we carefully thought about what is needed to make our institutes successful. When working at research institutions in Germany, the USA, and Japan, we were involved in the creation of new institutes to foster scientific discovery in favorable work environments. This includes the ZMBP in Tübingen, Germany (https://uni-tuebingen.de/fakultaeten/mathematisch-naturwissenschaftliche-fakultaet/fachbereiche/zentrum/zmbp/zmbp/), the Department of Plant Biology Carnegie Science at Stanford, USA (https://dps.carnegiescience.edu/), and the Institute of Transformative Bio-Molecules WPI-ITbM in Nagoya, Japan (http://www.itb.m.nagoya-u.ac.jp), one of the WPI Institutes. Common to all three institutes is their comparatively small size with 100–200 employees and substantial independence owing to an integrated administration. Other examples are the IGF, founded by Lothar Willmitzer in 1988 in Berlin; the Carnegie Institution of Science, founded in 1902 with a diverse set of small largely independent departments, the Scripps Institute of Oceanography in San Diego, USA, or the ZMBH in Heidelberg, Germany.

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Excellent institutes in Japan

ITbM has been conducting “needs-inspired” basic research and exploring new research areas of “plant chemical biology”, “chemical

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chronobiology”, and “chemistry-enabled live imaging” through intense interactions with leading plant/animal biology research (www.itbm.nagoya-u.ac.jp). The synergy of ITbM researchers’ research profile and the new research style at ITbM facilitated interdisciplinary research at a pace more rapidly than initially expected. ITbM started with the plan to bring biologists to chemistry, initiated by chemists. Despite the “discipline-based language barriers”, it generated a large number of publications at the interface of chemistry and biology during its comparatively short life. Its mixed laboratories of different disciplines have been highly effective and have led to the development of many new bio-functional molecules and molecular technologies. It maintained the identity of chemists and biologists, but expanded horizons and has created fantastic new tools like the chemical control of biological processes from products that were considered waste (www.itbm.nagoya-u.ac.jp). Many of the key discoveries sprung up from discussions of junior staff, e.g., the development of novel drugs to defeat witchweed in Africa (www.itbm.nagoya-u.ac.jp).

Through interviews with all ITbM faculty, we tried to distill a list of ingredients that seem important to us when building a new institute or reforming an existing one. Yet, we do not claim that we have discovered the magic formula for establishing a successful research institute. Many of the people we interviewed for this article needed to carefully think before they provided answers. While good cooking recipes are a good basis, many other things have to come together for a great meal. It is very hard to come up with a fool-proof recipe, but we can identify some of the key ingredients (Tables 1 and 2).

Table 1. Essential ingredients needed for a successful institute or research unit

| Ingredients | Features | Effect | Examples |
|-------------|----------|--------|----------|
| The idea for a menu and a plan | For example, to develop novel molecules that impact biology | IGF, Carnegie Plant Biology, ZMBP, ZMBH, ITbM |
| The right mix of people (magic ingredient, luck to find the right people) | Top scientists, trust, respect, perseverance, dedication, common goals | |
| Leadership | Ability to listen, support, but also say no, social skills, dedication, | |
| Sense of togetherness | | |
| Fun | | Productive atmosphere |
| Resources | Positions from the university for the professors, ideally also for additional researchers, project funding seems helpful as a motivation | IGF: government and industry ITbM: WPI and University |
| Interdisciplinarity | Going beyond borders of a discipline | Breakthroughs through expansion of horizons | ITbM chemistry with biology |
| Hard work | Long hours | |
| Luck | As always needed at all levels, science, personal interactions, the right people | |
| Internal administration | Embedded into the institute, admin is part of the success | Motivation of administrative personnel, higher efficiency | ITbM internal HR and finances Carnegie at department level; ZMBP and ZMBH, internal HR and finances |
| No roadmap, bottom-up | Foster creativity of all members | High flexibility and creativity for all members | |
| Building infrastructure | Same floor or building | Enhances collaborations | ITbM |
| | Mixed laboratories and offices | Multiple groups share the same space | |
| | Admin within same area | Personal contacts between admin and scientists | ITbM, Carnegie: department level; ZMBP and ZMBH |
| Supportive university | | |

People are the key ingredients, and the right team and spirit are essential. This requires compatible personalities, common
goals, a positive and open atmosphere, and everyone putting their egos second in lieu of the big goal. In particular, integration of the administrative personnel makes a huge difference, since they will be much more motivated when they feel that that success also hinges on their work and contributions. This is all easier and more efficient with smaller institutes of 100 to 200 people. Of course, one key ingredient that drives people in start-up companies is missing in the academic environment: the potential to become a millionaire. But we experienced that most academic scientists are extremely motivated by the potential to discover something new instead, so large parts of the concept of start-up companies can be incorporated. One key tool was the establishment of an internal grant system, based on WPI funds, to support research interactions at least two young investigators or postdocs at ITbM. This concept is not unique but also used successfully in CEPLAS, the Excellence Cluster in Plant Science in Germany, or Bio-X at Stanford University.

**Bottom-up science and flexibility**

In addition, the authors of this article favor freedom and bottom-up science, since it is hard to predict where science will be in 10 years, especially when new technologies appear almost on a daily basis and a technique from just two years ago is antiquated today. Other successful institutes have different perspectives—HHMI’s Janelia Farm for instance believes in roadmaps and predefined research topics (Rubin & O’Shea, 2019). Stanford’s Bio-X supports interdisciplinary research in biology and medicine. Bio-X operates at multiple levels: Researchers can obtain laboratory space in a dedicated building, the James Clark Center, which provides highly flexible space along with core research facilities. Typically, two PIs from different fields or schools—science, medicine, or engineering—share one large laboratory space. This concept appears to be built on a random collision model that puts scientists from different fields into a common laboratory. In addition, about 700 faculty from Stanford University are affiliated, which provides many opportunities for interdisciplinary activities, some of which are supported by funding schemes. The program is complemented by grad student fellowships. As Bio-X phrases it: “Bio-X fosters a collaborative culture and provides resources to explore ideas considered too experimental for federal funding”. Bio-X seems very successful, although it is hard to measure the contribution of cohabitation on the rate of breakthrough discoveries, which could be the outcome on the long run.

Surely, these different entities are hard to compare, given the differences in size and levels of investment—Janelia Farm cost US $500 million for the building and consumes 15% of the total annual budget of HHMI to support more than 350 scientists. We believe, however, though Janelia’s concept has been incredibly successful, small is the way to go for most countries. We therefore argue for creating more small and innovative institutes at top universities, making use of local strengths and opportunities.

Not every Excellence Cluster and WPI institute are highly successful, which is expected given the complex needs for the right ingredients, the right chefs and recipes. Yet, a major flaw common to any such excellence system is the limited funding period, often for 5 to 10 years without follow-up strategies to provide the most successful institutes with a mid- to long-term perspective. Such an approach is similar to supporting lots of start-up companies for a couple of years without an exit strategy, something no venture capital firm would do.

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**Similarities with start-up companies**

Many studies have analyzed the key ingredients and factors for a successful start-up company (Dyer et al, 2011; Author unknown,
2015). By contrast, only few studies explore the success factors of academic research institutes. Studies on start-up companies can indeed help since there are many similarities between starting a new institute and starting a company; there are of course also many differences notably financial incentives versus curiosity. There is a need for a systematic analysis of the comparatively small number of start-up research institutes in academia by social scientists that goes beyond the personal accounts of founders like us. Excellence Initiatives themselves have been analyzed by social scientists, but not the factors that lead to success or failure of individual clusters or institutes (www.isi.fraunhofer.de/content/dam/isi/dokumente/cc/eli-studien/2017/2017_StuDIS_11.pdf). It seems timely to carry out a full-fledged analysis by social scientists that could be at least a crude blueprint or cookbook to help new and ongoing initiatives (www.oecd.org/science/promoting-research-excellence.htm).

Nonetheless, some advice and literature are available for any scientist planning to start or improving existing institutes. Must-reads include articles on the social environment in a laboratory (Conti & Liu, 2015; Woolston, 2016; Broström, 2019) along with two books from Frans Johansson (The Medict effect and The Click moment): that luck plays an important role in success and that success is more likely in interdisciplinary areas where diverse perspectives, cultures, and disciplines come together to produce breakthroughs by making use of serendipity.

As outlined above, Excellence Initiatives have had a major impact on the university landscape in many countries. These initiatives have led to the foundation of a large number of excellent institutes and research clusters. One aspect however that has been neglected is the question of how one can secure this investment and ensure that the best institutes survive after their funding ends. These need either longer-term funding or at least help to transition and expand their funding base; otherwise, the investments are lost in the end as in the case of the IGF, which was terminated at its peak after one funding partner withdrew. Such outcomes are likely also not in the interest of governments that invested considerable tax money into these new research institutes.

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We strongly recommend developing concepts to provide extra follow-up support for a select group of successful institutes or clusters. This support can be substantially less than the initial funding to establish the institute as successful ones will have succeeded to secure research grants by that time. We suggest at a minimum an extension of funding at half the previous level with regular evaluations and termination when productivity declines because they must have acquired substantial grant funding. Alternatively, one could make successful institutes permanent by converting them into new entities analogous to, for example, the Max Planck Institutes that are supported by both the federal and state governments, but maintaining the structures that made them so successful.

In summary, this is an appeal to governments, large philanthropies, and funding agencies to create small research units with as much independence as possible, regular evaluations by a scientific board, and an extension of funding for the successful ones. Integrate administration as part of the institutes, limit their size, foster interdisciplinary research, create opportunities for crosstalk with other successful units. Such a concept would have to include architectural approaches to science buildings that allow for flexibility and the coexistence of multiple small institutes that can evolve, but also be replaced if not successful. This would copy some of the success recipes for start-up companies but also have an evolutionary aspect to fostering and supporting great science.

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