

Departments of history?

Bruce Gibb ponders a future without chemistry departments — and explains why this is a good thing.

Chemists tend to have a less conservative outlook than the average person on the street. This is, of course, stating the obvious. Orthodoxy and pushing the boundaries of chemical research are simply the worst of bedfellows. That's not to say that conservatism does not have an important role to play in chemistry — it stops the whole endeavour spinning out of control — but the trick I guess is to strike a fine balance: to be more, or less, conservative depending on the situation. So are chemists ever too conservative? I would suggest that one area where this criticism could potentially be levelled is in the evolution of academic chemistry.

Put it this way, are all of our chemistry departments optimally designed to teach students and generate research data that address important and current societal issues? Or is your chemistry department really a department of history? A product of the local history of the department, university and surrounding institutions — the precise structure of which has been inexorably shaped by chemical history. If it is, and it is not untypical for the structure of a department to be largely historically based, then it's probably not optimally tuned for addressing current issues. So a very important question, indeed one that is crucial to the future of the so-called central science, is how do you ensure that your department is shaped for the future rather than by the distant past? Change is required on multiple fronts.

Most modern departments have a divisional structure, and one can make many sound reasons for why this is so. Take for example an organic chemist, Professor R. B. Flask, at the University of Grand Traditions (UGT). As a member of the organic division at UGT, Prof. Flask can teach organic courses, grade cumulative exams that are organic chemistry in nature, and be in the front line when the department wishes to hire an organic chemist or bestow tenure and promotion on a colleague. To a certain extent this makes sense, after all Prof. Flask has built up expertise in the area of organic chemistry, and so is one of the better choices when it comes to making decisions that involve the teaching and research of the field. But what is an organic chemist? Show me a synthetic methodologist, and I will show you a protein engineer. Show me a natural-products chemist and I will show you an unnatural-products



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chemist. Show me someone who makes covalent bonds between molecules involving carbon, and I will show you someone who makes non-covalent bonds between molecules involving carbon.

In short, because of the breadth of researchers who work with carbon-based molecules, the catch-all term, 'organic chemistry' means so much that it doesn't mean that much at all. In the early days of chemistry the term was far more precise than it is today, but the field (in fact, all fields) simply keeps on expanding. On one level, the chemists at UGT fully appreciate this point. Yet an examination of the structure of the department reveals that the expertise within it can be readily carved up into a Venn diagram in which each of the subsets — beautifully named to reflect the grand traditions of chemistry: analytical, inorganic, organic and physical — have no overlap whatsoever with the others.

There are many things wrong with the set-up at UGT. First and foremost, the maturity of chemistry is such that society expects and demands that it addresses real-world issues. Society does not need an organic or inorganic chemist, it needs people who are going to

cure cancer, or solve the energy problems of the world by cheaply harvesting the energy of the sun or by devising an efficient means to sequester CO₂ and turn it into methanol. Now it's not exactly novel to state that a single chemist is unlikely to accomplish these goals. Neither will a lab filled with one kind of chemist. Instead, these problems are best solved by interdisciplinary research and collaboration. With this in mind, UGT Chemistry needs to change the very nature of its divisions, moving away from those that reflect chemical history and towards contemporary chemical reality — and then expand on this new structure by hiring new faculty that fit the particular niches the department finds attractive. And herein lie several issues.

First, there is an issue of relative rates — the time-frame for completely overhauling the structure of a department is unfortunately longer than the time someone typically spends as chairman of a department. Moreover, if funding is to be sought to help with the enterprise, what funding agency can readily commit over this relatively long time-period? There is also the issue of fear of the commitment. Imagine UGT formalizes a

Division of Green Energy; comprising (alas using again the traditional naming system) three organic chemists, three inorganic chemists and two physical chemists. It brought in three new faculty to complete the team, only to discover that a change in government has resulted in green energy falling somewhat out of favour because the politician de jour said in his or her campaign that, “there is no such thing as Hubbert’s Peak!” (K. S. Deffeyes *Beyond Oil: The View from Hubbert’s Peak*; Hill and Wang, 2005). Now that statement didn’t make scientific sense, but it made perfect economic sense considering the politician received backing from a major oil company, and like all oil companies its share value is dictated first and foremost by how much oil it reports having in reserve.

So in the short-term, for want of a better phrase, the department backed a loser. A conservative approach, remaining with the old system and allowing individual researchers to associate with a traditional and non-specific banner, would be safer. In the short-term. The good news is that the timescale for reorienting the department is probably not longer than the typical political career, and so taking a bit of a gamble, UGT Chemistry decides to push forward with its changes. After all, there is no getting around the fact that chemistry is now so broad that no department can cover all the bases. This simple chemical fact means that UGT can either change stochastically, or it can plan themes — and if it’s going to plan, it must consider the needs of society. This is not to say that a department should turn its back on fundamental research — we are not smart enough, nor sufficiently prescient, to ignore this fountain of serendipity. Indeed, a balanced department should be composed of a spectrum of research types, from those whose context is readily justifiable in terms of societal needs, to those whose context is hard to justify using such laser-like metrics. But wherever an individual’s research lies in this spectrum, the context ought to be what society needs, not what history provided us.

Move a few years into the future and UGT Chemistry has done more than change the name of its divisions, let’s say to the Divisions of Green Energy, Oncology Chemistry, Pollution Monitoring and Remediation, and Systems Biology. It has also created considerable overlap with the subsets in its research Venn diagram, and by hiring interdisciplinary researchers, blurred the edges between these overlapping sets. Thus Prof. Flask had been joined by (to name but four): an expert in sub-attosecond pulse spectroscopy (Green Energy and Oncology Chemistry), an expert in cascade reaction total syntheses (Green Energy and Oncology Chemistry), a transcription network (re)

designer (Oncology Chemistry and Systems Biology) and a specialist in self-repairing, photovoltaic molecular arrays (Green Energy and Systems Biology). In redefining itself as a department, UGT Chemistry offers plenty of opportunity to collaborate and discuss mutual interests. In fact, the newfound collaborative atmosphere has highlighted just how poorly designed the chemistry building is as a venue for people to interact in. That new building the department has been promised will definitely not be your standard design, but will be an open, pleasant environment specifically designed to foster collaboration.

How do you ensure that your department is shaped for the future rather than by the distant past?

In redefining itself, UGT Chemistry faced many internal challenges. Who was to teach an organic class if there isn’t an organic division? Actually there were no organic classes, and no single organic chemistry textbook. Instead there were a series of classes where organic chemistry predominated, each tooled to the needs of the subset of students in question. Team teaching was used in many sections and, in fact, the pre-class discussions between the faculty members turned out to be a great incubator for collaborative research. One example of team teaching was in the pre-med sections (Chemistry of Living Systems I and II) that were taught by an organic chemist and a biochemist. This helped ensure that the course was not defined by history, but by salient, contemporary topics of interest and relevance to the student population. Gone were the obligatory biographies in undergraduate organic textbooks — the ones of major figures in chemical history that are an inspiration to all of us chemists... but to the vast majority of students are little more than gruff old white men with big beards. Gone were the endless variations to chemical reactions devised in the nineteenth century, the ones that to the neophyte all look the same and caused much bemusement. Instead, these two classes focused on only the fundamentals of organic chemistry that pertain to biochemistry; fundamentals that were discussed not from a chemical-history perspective, but in a biosystems context.

UGT Chemistry also faced external challenges. Was it still a chemistry department in the eyes of its national organization? Yes. But at the divisional level there were issues concerning how the training of its students was viewed, both by other departments and national organizations. As a result, UGT Chemistry still had — to some extent — to

teach to the exam, particularly external exams for graduate school and medical school, because the external system was still very much geared to the unusual idea that future graduates in medicine really needed to know three chapters of carbonyl chemistry if they were to be intelligent, resourceful and compassionate doctors! But while acknowledging the realpolitik of power — and appreciating that large concentrations of power adapt more slowly — UGT Chemistry pushed ahead.

In changing the very soul of the department, the divisional chairs at UGT Chemistry also worked at the higher levels. A centre of Green Energy was created that involved both chemists and engineers. Another was formed between the biochemists, computer scientists and mathematicians to work on systems-biology research. The bonds within the chemistry department weakened while new bonds between those focused on salient, interdisciplinary topics strengthened. And so while still teaching core chemical concepts and carrying out fundamental research, UGT Chemistry evolved into something quite new — an entity whose very existence centred on bestowing future scientists with the knowledge they needed in the contemporary world, while undertaking research that most effectively meshed with societal issues. Ultimately, both of the aforementioned centres became departments in their own right, and through wise stewardship became flagships of the university. And in this distant future the chemistry department (and several others at UGT) faded into history; their passing a time of joy rather than a sombre wake. Of course the scientists, engineers and mathematicians were still gainfully employed, they just worked in very different environments from what we know today.

In trail-blazing a path to the future, the whole of UGT reconfigured itself with many incentives, such as generous in-house sabbaticals to encourage faculty to step out of the research limelight and slowly bring about these difficult changes. The UGT Strategic Development Office, by careful hiring of faculty and administrators, ultimately morphed into a meta-department; a department whose research focused on how departments could best work together and undertake research. And it was in an office of this meta-department that one day the idea came about to change the name of the institution... to the University of Great Opportunity. □

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