STINT
Stiftelsen för internationalisering av högre utbildning och forskning
The Swedish Foundation for International Cooperation in Research and Higher Education

STINT XinT – Excellence in Teaching Program 2012

Final Report from a Semester at the Department of Chemical and Biomolecular Engineering, National University of Singapore

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August 1 – December 31, 2012

NUS National University of Singapore

1 Introduction

During the last few years, I have felt an increasing urge to go on sabbatical leave. Sabbatical leave is usually taken approximately every seventh year in order to reinvigorate and restore one's academic energies, and to provide a base for future intellectual development and achievement. After 15 years at Chalmers I felt that it was urgently time to spend some time somewhere else, for this very reason. My primary aim was to focus my sabbatical leave on teaching rather than research, since teaching is one of the primary reasons for which I decided to opt for an academic career. In September 2011, I received notification of the call for applications to STINT's Excellence in Teaching (XinT) program. As formulated by STINT, the objective of this program is as follows: *The STINT XinT Programme aims to develop individuals as well as institutions. By offering Swedish teachers international experiences based on their role as teachers rather than as researchers, the Foundation wishes to contribute to the renewal of Swedish education and the creation of new academic networks. Participating institutions are strongly encouraged to learn from and use the experiences of the returning teachers in order to generate positive spillover effects. With the scholarship programme the Foundation wishes to stress that academic teachers need international references and experiences.*

I had looked into this program earlier, but decided not to apply because at the time the program was essentially geared towards North American Liberal Arts Colleges. I obtained my PhD at Dartmouth College, a top-ranking Ivy Leave institution in Hanover, New Hampshire, and felt that I would not gain much from spending another 6 months in such an institution. I looked in the call for Excellence in Teaching 2012, and noted that Universities in Singapore and Hong-Kong had been added to the program. This was of great interest to me. I had travelled to China several times, as member in various "research delegations", but concluded that establishing meaningful contacts takes time and requires a stay of several months at least. Given the rising importance of Asian economies, and the number of Asian students applying to our MSc programs at Chalmers, I realized that the opportunity I had been dreaming of for many years was now knocking on my door. After having looked into the academic programs at the three potential Asian host universities, I rapidly concluded that the Chemical Engineering program at the National University of Singapore (NUS) would be the perfect place for a teaching sabbatical. I therefore decided to apply to the STINT's Excellence in Teaching program for 2012. I received enthusiastic support from my family, my home department at Chalmers, as well as Chalmers Learning Centre. My application was favourably viewed by STINT, and in February 2012 I was offered an Excellence in Teaching Fellowship Grant to spend the Autumn semester at the Department of Chemical and Biomolecular Engineering at the National University of Singapore (NUS). I am very grateful to all the people who made this possible.

New perspective: View of the Central Business District of Singapore, seen through the eye of the Singapore Flyer

Note: some of the pictures in this report are private pictures. Other graphic material is taken from NUS official presentation material.

2 The Department of Chemical and Biomolecular Engineering (ChBE)at NUS

The ChBE department at NUS is internationally acclaimed for its teaching and research. **It was ranked at place 7 in the 2012 QS Ranking of Chemical Engineering Universities**, up from place 11 in 2011. It is the highest ranked Chemical Engineering program in Asia. This is an accomplishment that they are proud of and eager to maintain. Significant effort is put into continuous follow-up of different university ranking results, as well as pro-active benchmarking efforts regarding number of publications, number of publications in high-impact journals, H-index scores, etc. NUS follows standards set by high-ranked US universities when recruiting new staff or considering tenure applications from young faculty. There is much awareness that "staying in the race" with other top ranking universities is extremely tough, but at this point there is no indication that there will be a change of direction. NUS-ChBE is thus clearly an interesting place to be to study the practice of Excellence, and also an interesting place to study the consequences of chasing high QS ranking scores, as many universities (including Chalmers), are currently doing.

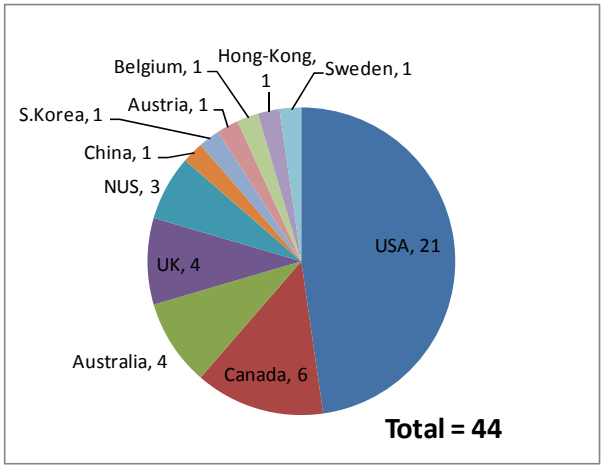
The **department's history** mirrors the history of Singapore's Chemical process sector. In 1963, Applied Chemistry was introduced in the Department of Chemistry in the University of Singapore's Faculty of Science, in order to meet the needs of the young and growing chemical process industry. The continued expansion of the chemical process industry created a substantial demand for chemical engineers leading to the founding of the Department of Chemical Engineering in 1975. The department was transferred to the Faculty of Engineering in 1979. During the 1990s, Undergraduate and Graduate programs in Environmental Engineering were developed, and in 1998 the department was renamed as Department of Chemical and Environmental Engineering. Thereafter, substantial effort was put into obtaining international accreditation of the Chemical Engineering and Environmental Engineering programs. In 1999, the Chemical Engineering Program received substantial equivalency recognition from the (US) Accreditation Board for Engineering and Technology (ABET), and in 2001 MEng level reaccreditation as well as accreditation of the BEng (Chemical) and BEng (Environmental) programs was obtained from the (UK) Institution of Chemical Engineers (IChemE). The

current department name was adopted in 2004, reflecting increasing activities in the biomolecular and biopharmaceutical areas. In its current organizational form, the department does not include formal divisions. Research is conducted in informal clusters.

In 2012, the **department staff population** was as follows:

- 42 Faculty Members + 4 Visiting Professors and 9 Adjunct Staff
- 7 Teaching Staff
- 98 Research Staff
- 10 Administrative Staff
- 33 Laboratory Staff

Almost all faculty members are from Asian countries. Most obtained their PhD degrees in top universities in N. America, Australia and the UK (see chart below). Only 3 faculty members obtained their PhD from NUS. This is a sharp contrast to my own immediate environment at Chalmers, where many teachers and researchers obtained their PhD at Chalmers.



ChBE Faculty members – Country in which PhD degree was obtained

The department offers a number of **educational programs at the Undergraduate and Post-Graduate levels**. The programs currently offered are as follows:

Undergraduate programs

- B.Eng. (Chemical Eng.) with possible specializations in Biomolecular Eng., Microelectronics Processing or Process & Systems Eng.
- B.Tech. (Chemical Engineering)

Postgraduate programs

- PhD and MEng
- NUS-UIUC Joint PhD (UIUC = University of Illinois at Urbana-Champaign)
- MSc (Chemical Engineering)
- MSc (Safety, Health & Environmental Technology)

Enrolment: 1,192 Undergraduate Students and 346 Graduate Students as of October 2012. Enrolment for academic year 2012/2013 in the Chem.Eng. B.Eng (total number followed by male/female breakdown in brackets): 1st year: 284 (220/64); 2nd year: 304 (218/86); 3rd year: 334 (216/118); 4th year: 284 (179/105). Degrees awarded in 2012 as per October 2012: 257 BEng degrees, 61 MSc de-

grees, 18 MEng degrees, 40 PhD degrees. These numbers are somewhat difficult to compare with Chalmers, which has a different program structure. Chalmers admits 190 students per year to its 4 programs in the Chemical Engineering area: 60 to the 5-year combined BEng/MEng Chem.Eng. program, 35 to the similarly structured Chem.Eng. with Physics, 70 to the 5 year Bio-technology program, and 25 to the three year BEng program. It should be noted that Chalmers has adopted the 3+2 year Bologna model program structure, whereas NUS offers programs structured in a way that is similar to US Universities. The NUS ChE student body is primarily constituted of Singaporean students (75% of students admitted in 2012). Of the ramining25%, around half are from China, and the other half from neighbouring ASEAN countries, mostly Malaysia and Indonesia. This is similar to the situation in Sweden, where the student body in undergraduate programs is primarily made up of national students, with a number of EU students entering at the MSc level (non-EU foreign students dropped sharply 2 years ago when Chalmers and many other Swedish universities started to charge tuition fees for this group of students).

Students admitted to the undergraduate programs at NUS have top level grades. From discussions with colleagues, I found out that Chemical Engineering is the third choice for students leaving High School with top grades, behind Medicine and Dentistry. It is the Engineering program that attracts the best students each year. Interest for Engineering studies has dwindled over the last years, and more and more students have been admitted to the Chemical Engineering program (the policy of the Faculty of Engineering has so far been to increase the number of students admitted to the Chemical Engineering program in order to maintain the total number of students admitted to the Faculty of Engineering, and maintain high entrance level grades for students entering their first year of study). This has put significant strain on the Dept of ChBE, since the number of students has more or less doubled over a 10 year period, but the number of teaching staff has not increased accordingly. The department currently has a student:faculty ratio of 33:1, which some claim to be the highest level in the world.

The Chemical Engineering undergraduate program is also seeing **increasing competition for students with Nanyang Technological University (NTU)**. Enrolment in NTU's Chemical and Biomolecular Engineering program is currently approximately 175 students per class, i.e. about 100 less than the NUS program. According to published data about grade levels of students admitted to the Chemical Engineering programs at NUS and NTU, NUS so far manages to attract slightly better students that NTU. In all this implies that NTU and NUS admit around 450 students in all each year. According to figures published by the Ministry of Education, approximately 90% of graduates from these programs find relevant employment within 6 months of graduation, with little difference in entry-level salaries between NUS and NTU graduates. This clearly shows that the local demand for Chemical Engineers is very strong in Singapore.

Academic staff duties: academic staff are expected to devote approx 40% of their time to teaching, 40% to research and 20% to outreach, service or administration. From what I can gather, this allocation is more or less standard for all staff categories, from Assistant Professor to Full Professor. There are well-established procedures for keeping track of each person's contribution to teaching, and each academic staff member is expected to contribute with a (more or less) fixed volume of teaching activities each year. There are a number of Teaching-track staff members (7 as of October 2012). Given the increasing teaching load, the Dept is currently in the process of recruiting additional Teaching-

track staff for appointments at all levels. Teaching-track staff are expected to excel in teaching and educational leadership including administration. Thus, the Dept is following an ongoing trend in the academic world, i.e. **differentiating between Teaching-track and Research-track positions**, and recognizing and encouraging pedagogical research and innovation. It should also be noted that, as stated earlier, UC Berkeley criteria are applied fully for tenure promotion, which implies that good performance in teaching activities is essential for obtaining tenure. Student evaluations play a strong role here, as well as appraisals of lecturing abilities by senior staff members. This is again in contrast to Chalmers, where teaching-track positions are being more or less phased out as part of a policy to profile the university as a research focused academic institution in which all teaching staff is also engaged in research.

Research themes at ChBE: the department has a lot of research in traditional core chemical engineering areas such as process and systems engineering, catalysis and reaction engineering, advanced separation processes and transport phenomena. In recent years, the department has also expanded into the fields of molecular biology and life sciences to include research in biomedicine, biotechnology, systems biology, protein engineering, drug-delivery systems, and chemotherapeutic engineering, among others. The department also conducts research in functionalized and smart materials (e.g., for biosensors, molecular and polymer electronics, novel smart membranes for separation processes and novel optoelectronic and photonic materials) and nano-structured materials (e.g., for new catalysts and fuel cells).

3 Content and Reflection over my teaching duties at NUS-ChBE

The B.Eng Chemical Engineering (ChE) curriculum at NUS is a 4-year program. In order to graduate, students are required to complete a minimum of 161 MCs (Modular Credits) with a Cumulative Average Point (CAP) score ≥ 2.0 (maximum possible CAP = 5.0). A normal class (or module) is usually 4 MCs. The degree requirements are as follows:

- **University requirements: 20 MCs** consisting of 8 MCs of General Education Modules (at least one from the Humanities and Social Sciences), 1 Singapore Studies module (4 MC) and 2 Breadth Modules (8 MCs) taken outside the Faculty of Engineering.
- **Faculty of Engineering requirements: 10 MCs:** *Critical Thinking and Writing* (4 MCs), *Human Capital in Organizations* (3 MCs), and *Engineering Professionalism* (3 MCs).
- **Unrestricted Elective Modules: 20 MCs**
- **Science and Mathematics Modules (28 MCs):** Math I and II, Organic Chemistry for Engineers, General and Physical Chemistry for Engineers, Introduction to Programming with Matlab, Fundamentals of Biochemistry, Introductory Materials Science and Engineering
- **Chemical & General Engineering Core Modules (67 MCs)**: Chem. Eng. Principles, Chem. Eng. Labs I, II and III, Chem. Kinetics and Reactor Design, Chem. Eng. Thermodynamics, Fluid Mechanics, Heat and Mass Transfer, Process Dynamics and Control, Particle Technology, Separation Processes, Process Modeling and Numerical Simulation, Process Safety, Health & Environment, B.Eng. Dissertation, Capstone Design Project
- **Chemical Engineering Technical Electives (16 MCs)**: offered in three *specialization tracks*: Microelectronics Processing, Biomolecular Eng. and Process Systems Eng.

In summary, the curriculum focus is mainly on classic chemical engineering core skills. The opportunities for specialization modules are relatively limited (16 MCs). Students wishing to specialize must apply to the MSc or MEng programs.

My teaching duties were agreed upon during my planning visit to NUS in March 2012 and were as follows:

1. Co-facilitator of module CN4205R "Process Systems Engineering", together with Prof. G.P. Rangaiah. I was fully responsible for Parts I (*Pinch Analysis and Process Integration* - 50% of lecture content) and II (*Data Reconciliation and Gross Error Detection* - 25% of lecture content) of the module. Prof Rangaiah was responsible for Part III (*Process Optimization* - remaining 25% of lecture content). This module was a Technical Elective for 4th year students ChE students offered within the Process Systems Engineering specialization track
2. Co-advisor of a Final Year Project: *Techno-Economic and Environmental Analysis of Microalgae Biodiesel Systems*. Main advisor: Assistant Prof. Dong-Yup Lee. My role was to attend regular follow-up meetings (2 per month on average), read interim reports and provide feedback, be available for additional advisory meetings, as required (approximately one meeting per month in addition to the formal follow-up meetings). The project activity period terminates on Dec 31, and the thesis project report is due towards the end of January. Within the limits of my availability, I plan to provide feedback on the final report document. We have plans to invite the student to do further work on the project after completion of the Final Year Project requirements, which will hopefully lead to a common scientific publication.

Summary of my experience as Facilitator of the Process Systems Engineering module: 23 students chose the elective (less than expected, probably because the module was essentially unknown for the students since it had not been offered since Spring 2004). The teaching load was intensive (given that I was teaching the module for the first time and all teaching materials had to be produced from scratch): three 1 hr lectures and one tutorial session (1 hr) per week during the period 14 August through 26 October, with a one week recess (no classes) at the end of September. Thereafter followed grading of a written Test on Part II of the module in early November, as well as report-grading and oral examination of 8 mini-project reports related to part I of the module (completed Nov 16). As mentioned above, the module was last taught in Spring 2004, with a significantly different content. Thus, most teaching material had to be produced from scratch. However, Part I of the module (Pinch Analysis and Process Integration) was relatively similar to a module that I teach at my home University (Chalmers) (KVM013, *Industrial Energy Systems*) to ChE and MechE students at a similar level (4th year of engineering studies). Thus I had a significant pool of experience and teaching material at my disposal. It was initially planned to have Smith's *Chemical Process Design and Integration* as a text for Part I. This was changed one week before the start of the module when it was discovered that Kemp's *Pinch Analysis and Process Integration* was available as an e-book through the NUS library, whereas Smith's book was only available in limited number of hard copies. Although this caused significant stress at the moment of the decision, it was a good choice, since it has been my intention for a number of years to switch to this book as a textbook for the module that I teach at Chalmers, and I was very glad to have the opportunity to explore this textbook as teaching resource within the framework of the XinT Fellowship. In summary, for Part I, I produced a full set

of new lecture PowerPoint slides based on Kemp's textbook, a full set of homework assignments and solutions (inspired in part by assignments from previous modules offerings, in part by set problems in Smith's textbook), 2 in-class closed book continuous assessment tests, and one mini-project assignment. I particularly liked having to solve my own homework sets. I found that I was rather rusty at calculations initially, but that I picked up speed fast and found that implementing the material I teach to solve homework problems really improved the quality of my lecturing.

Part II of the module (*Data Reconciliation and Gross Error Detection*) was completely new to me. Although this part of the module was relatively short (3 weeks of class), preparation of lectures, homework assignments and tutorials demanded a major effort from me to keep up with the intensive pace of the class. Furthermore, Part II of the module was intended as an introduction to the subject, not an in-depth exposure to the material. There was thus the additional challenge of selecting the material to be presented in class. Fortunately, I was provided with lecture notes from the last time the module was taught, so the choice of material was essentially done for me. My task was to read the relevant book chapters, prepare Powerpoint slides, and prepare tutorial classes and homework solutions. Again, I had homework assignments from the previous module offering. Preparation for Part II of the module was definitely a highlight of my teaching experience. I was forced to learn something completely new, produce lecture material, read the textbook, solve home assignments, learn how to use Excel to perform basic matrix calculations, and more. What a pity I don't do this more often.

Regarding **examination**, I followed the ChBE recommendation of continuous assessment. The final grade for the module was based upon 6 continuous assessment items: 4 tests (2 on Part I of the module and one each on Parts II and III, in total 65% of the final grade), one mini-project (25% of the final grade) and one paper review assignment (10% of the grade). There was no final examination. This form of continuous assessment struck me more much more natural than basing the full module grade on a single final written examination, as is customary at Chalmers. This is something that I will definitely follow up on in the future.

Looking back on my three months as teacher, I can confidently say that I was most impressed by the ability and willingness of my students to work hard and to learn. Class attendance (for both lectures and tutorials) was very high (80-90% of students at least). Students worked diligently on their homework assignments and never complained about the volume of work. On the negative side, it was hard to get students to be orally active in class (from my discussions with colleagues and students I gathered that this is some form of collective attitude among NUS students). However, during breaks and after classes, students often came to me with questions. I would often get questions sent via e-mail, often well formulated, and often of the type "In your lecture slides you state XXX, however I have read the related material in the book and thought about this more and I think that the correct statement should be YYY. Is this correct?" Powerpoint handouts were made available to students ahead of lectures, and I got a clear impression that a significant proportion of students prepared lectures ahead of time and attended lectures to get extra input about trickier concepts. I was a little disappointed at the tutorial sessions. I had hoped and expected better participation during these sessions. Again, my enquiries with colleagues and students indicated that relatively passive attitude during tutorial sessions was a relatively standard attitude among final year NUS students, but I nevertheless felt a little frustrated at not having managed to break this trend as much as I would have liked to. I was impressed with student test results. Final year students are more used to open-book

exams focused on problem-solving. My tests were closed-book, with a mix of simple problem solving questions, and questions related to explaining theory and procedure. Although students did not like this, they nevertheless performed well in these tests. Finally, my most positive experience was the heat integration mini-project. The project was introduced to the class on Sept 18, and the deadline for report submission was Oct 15. The time period for the project included the recess week. No tutorial time was scheduled for the project. I was available 3 hours per week for consultation. On the whole, students did not come to consult me as much as I expected. Students worked hard at this project, which I see as a clear indication that they found it interesting (this was confirmed by the feedback they provided during the project presentation seminar). I saw no indication that students copied results from each other. All project reports and results differed significantly from each other. Again, I took this as an indication that students were interested in the assignment, and thus interested in doing the work themselves so as to learn as much as possible. I was positively surprised by the quality of results that most groups managed to achieve, given the tight time-frame for the project. Students were however very clear that they thought that the work-load for the project was unreasonably high, given the weighting (25%) of this project in the final grade for the module.

In terms of interaction with my colleagues, I found myself left to run things on my own more than I anticipated. I had no Teaching Assistant, so I was left to figure many things out on my own, which was very instructive but also time-consuming and at times frustrating. Also, this tended to lead to my doing things the way I am used to doing them at Chalmers, rather than learning new approaches. However, based on student reactions and comments, I concluded that the way that I manage my teaching at Chalmers is relatively similar to the expectations of NUS students, which is a gratifying observation. At the end of the module I felt rather proud at the positive feedback from students, and the satisfaction of having successfully taught a class to bright and hard-working students, that so clearly corresponded to their expectations. In terms of Faculty interaction, I received significant help and support from my co-teacher Prof Rangaiah during the initial planning part of my stay. Unfortunately, he was away most of the time in September and October, and to a certain extent I missed the presence of a colleague to discuss my ongoing teaching experience with on a regular basis.

Summary of my experience as FYP co-advisor: according to the main advisor of this project, the student I co-advised was exceptionally smart. I was certainly impressed by his work capacity and aptitude to conduct advanced literature searches and extract meaningful data from relevant scientific publications. He was also excellent at preparing presentations for our twice per month follow-up meetings. He also turned out to be good at report writing. He was definitely on a par, if not better, than the better students I have advised in the FYPs at Chalmers. As stated earlier, there is a good chance that this project will lead to a scientific publication in the future.

4 Practical Issues and Experience

4.1 Stipend information, planning trip and preparation

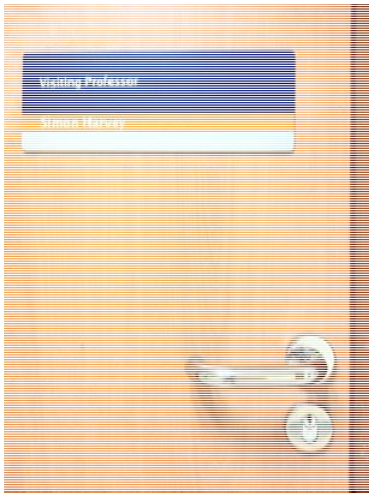
Planning trip: the planning trip is essential. I am grateful that the amount budgeted by STINT was sufficient to cover travel expenses for my wife who accompanied me. Without her presence, it would have been impossible to visit the 8-9 schools that were necessary before finding a suitable school

with available space for our two children. I was very impressed by the professional efforts made by the Dean's office at NUS-ChBE in organizing my visit here. The Department's manager was extremely helpful in handling all e-mail queries I had. She was also most helpful in assisting my wife to make headway regarding schooling options for our children. During my visit, I got to meet a number of faculty members, visit facilities, define my teaching duties, meet with administrators who were assigned to help me with the Employment Pass application, as well as tour the showcase apartment at Kent Vale, where NUS staff housing is located. During the planning trip I was given access to a Visitor's office with computer and temporary login access. I was very impressed by the Department's ability to welcome and take care of visitors. We have a lot to learn in this respect. The only less positive note to the planning visit was that I felt that the Dept tried to convince me to accept a very heavy teaching load. In addition to the Technical Elective which I ended up teaching, they would also have liked me to co-teach a Chemical Engineering Core module (e.g. Chemical Engineering Thermodynamics). At the time this seemed like a heavy load, so I declined. In retrospect, I realize that such a load would have been close to impossible. I also realize that such a load is significantly more than the Department expects of its own faculty members, which strikes me as an unacceptable expectation to have of a short-term Visiting Professor.

Preparation, Planning and Interaction with STINT. The period from the return from the planning trip until the end of June was very intensive. I was surprised at the demands from the Singapore Ministry of Manpower in connection with my application for an Employment Pass for myself and Dependent Passes for my children. Although the procedure went smoothly, I had to produce volumes of documents. I was impressed by the rapidity with which NUS sent a full contract proposal to me after my planning trip. Administration at the Swedish end was much slower. NUS and Singaporean International Schools are very accustomed to handling foreign visitors. Chalmers has no routines for sending staff on long-term appointments abroad. Our department's human resource specialist was supportive and helpful, but it was clear that all my questions about leave-of-absence, insurance, etc were new to her and to her HR colleagues. Insurance turned out to be a complication. At the end, I took only 90% leave of absence, so Chalmers accepted to purchase special insurance for me. I had to purchase insurance for my wife and children privately. This was not particularly expense (we chose to extend the standard 30-day travel insurance coverage in our "Home insurance" package). However, I would recommend that STINT considers including coverage for this type of insurance in their XinT contract. This would have saved me a significant amount of time and hassle at a relatively low cost. The insurance issue made me feel a little bitter at been trapped between STINT's statement that they were only paying a stipend and had no employer obligations, and Chalmers statement that they had no employer obligation towards employees on leave of absence. Finally, I would like to state that I was not very impressed by STINT's administration service during this period. The final contract document was signed very late (end of June), long after all administrative procedures in Singapore. I would strongly recommend that STINT does a better job of drawing up a check-list of all documents necessary to finalize the contract. More transparency and better documentation of the way the stipend amount is calculated would also most likely be appreciated by future XinT Fellows, as well as a clear time-table for the payments of the fellowship. Payment instalment #2 was initially promised in September, but the payment was delayed several times and finally occurred at the end of October. This was fortunately offset by the amazing inefficiency of the NUS Housing Office which meant that invoicing of monthly rental charges did not start until October. Of note here is that NUS charged

XinT Fellows market rental rates instead of the subsidized rental rates charged to NUS Faculty members. Given our significant contribution to NUS academics, this decision is rather surprising, to say the least.

4.2 Arrival in Singapore



This went very smoothly. Our apartment at Kent Vale was available as planned, and no problems with key pick-up on arrival. The apartment was spacious and welcoming. I reported to NUS as planned on August 1. I was pleasantly surprised to find my name on the door of my office…

I was also impressed by the fact that everything had been well-prepared in anticipation of my arrival: computer account, email account, etc. Again, I think that Chalmers has a lot to learn on this front also. Department staff were readily available to show me around and help. All in all my first impression of NUS was very positive. Within a few days of my arrival, the Head of the Department sent out a professional internal letter to all department staff announcing my arrival and wishing me welcome to NUS.

In retrospect I can also say that I am a little disappointed that the central administration of NUS (more specifically, the Office of the Provost for Education, who administrates arrangements with STINT concerning the XinT program) made no effort to contact me upon arrival. At the end of my stay, in late November, I (together with Malin Nilsson, the other XinT 2012 Fellow at NUS) was invited to a meeting with Professor Bernard Tan, Vice Provost for Education, and Associate Prof Chng, Associate Provost for Undergraduate Education. We had an interesting informal meeting during which we discussed our experience at NUS as XinT Fellows and discussed ways in which the XinT format could be improved. The meeting was interesting and productive, and I am sure that if we had also had a meeting at this level in early August, it would have been beneficial for all parties involved. However, I also became clearly aware during the November 2012 meeting that the NUS-STINT collaboration is still very young, and that NUS administration is still in the learning phase regarding the STINT XinT program. Hence, this note is maybe more of a suggestion for future development than a complaint that something that should have been in place was not working.

4.3 Work atmosphere

The ChBE Dept lacks the regular informal social forums that we are used to in Sweden. There are no regular daily tea/coffee breaks, and for many reasons all faculty members keep their office doors firmly shut. There was no clear habit of knocking on doors to have lunch together, and I was a little surprised at how little effort was made to incorporate me socially in the department. I found making social contacts difficult given the lack of venues in which to do this. The only regular venue was the Friday afternoon pizza at 16:30. It took a while for me to realize that this took place (I learned about it accidentally) and since it was not organized systematically every Friday it also took a while for me to make sure that I was permanently included on the announcement email list. It was also not a great

time to have such a gathering – it conflicted often with family plans for Friday evening, thus I was not able to attend the Friday Teas as often as I would have liked to.

Otherwise, the whole department clearly had to struggle the strain of the teaching load with the large student body, a 33:1 student:staff ratio and the perpetual pressure of research performance. Preparation for my own teaching, as well as demands from my PhD students back in Sweden kept me very busy. And my colleagues at ChBE seemed perpetually busy. I was also struck by the nature of conversations with colleagues about teaching. I often got the impression that teaching is considered by many to be a bit of a drag. I heard many comments about the time demands of teaching, demanding students (including unending questions via e-mail), classes so large that correcting exam papers, hassle around term paper projects. The fact that student evaluations have significant weight in annual appraisals and tenure promotion was also mentioned. Nothing unusual maybe, but not quite what I had imagined. Somehow the fact that NUS was selected by STINT as been a university offering educational training of very high quality had lead me to believe that I would be spending 5 months in an atmosphere where teaching was discussed all the time, where pedagogical experiments would be happening all over the place, and where there would a large number of practices in place for ensuring a top-notch learning experience for students. Instead of which I found that standard practices are in fact relatively traditional, and that many faculty members find that teaching takes time from research (which probably speaks volumes about what the requirements for tenure and promotion really are).

4.4 Other activities during the semester

I was impressed by the number of invitations to attend seminars held by visitors. NUS-ChBE has a continuous flow of excellent researchers from around the world (but mostly from the US) visiting them. The highlight for me was a seminar held by Gavin Towler, Vice President and Chief Technology Officer at UOP, a leading supplier of catalysts, process technology, proprietary equipment and services to the oil, gas and petrochemical industries. He is co-author of "Chemical Engineering Design", a textbook on process design which we use in our Chemical Engineering teaching at Chalmers. During this seminar, I also became aware that one of my Visiting Faculty colleagues at ChBE, Santi Kulprathipanja, was a research fellow from UOP. I talked to him once during the Friday Tea session and he told me that he was here to teach a course about Innovation Management, which he claimed was quite new for him. It turns out that he is UOP's top patent performer, with more than 100 patents to his name!

Otherwise, the faculty seminars had an annoying habit of clashing with my teaching on Tuesday and Thursday afternoons. And the usual problem with seminar announcements in a wide-ranging academic environment: many titles meant very little to me, and also seemed to be much more from the realm of basic science than close to process engineering industrial process. In addition to University research, a lot of research in Singapore is conducted in major research institutes, mainly under the government lead agency A*STAR (Agency for Science, Technology and Research). A*STAR is responsible for a number of research institutes, including ICES (Institute of Chemical and Engineering Sciences) with its main research facilities located on Jurong Island, home to one of the world's largest petro-chemical clusters. I had hoped and expected that ICES would be more active in organizing seminars and conferences focused on industry-near research. This was however not the case. I attended one ICES conference event in commemoration of their 10^{th} anniversary. The conference included some interesting speakers, but on the whole I found it a little unstructured and disappoint-

ing. It did, however, give me the opportunity to travel out to Jurong Island, where I was really struck by the sheer magnitude of the petrochemical cluster, and amazed at the speed with which the huge complex was built, mostly on recovered land.

Singapore of course has the advantage of being a capital city, and the main oil hub of South East Asia. I was able to attend an event organized within the framework of the annual SIEW (Singapore International Energy Week), featuring interesting speakers talking about Singapore's prospects as a regional hub for LNG (Liquefied Natural Gas). The organizers had invited high-level speakers from the US, Australia and the Middle East to ensure a mix of international perspectives. Such a mix of international guest from around the globe would be unthinkable in Göteborg. This conference was announced at NUS through ESI (Energy Studies Institute). I had hoped that ESI would be more active in organizing energy related seminars. I subscribed immediately to their newsletter upon arrival at NUS, but as it turned out their level of activity was rather a disappointment.

Finally, I was very impressed by the number of activities proposed by CDTL, the Centre for Development of Teaching and Learning. In particular, they organized regular workshops and seminars to address specific issues related to teaching. These workshops were often short (1-3 hours) and addressed very specific issues. I attended three such seminars: "Effective Use of Questioning During Teaching", "Conducting Action Research in your Classroom", Developing Institutional Scholarship of Teaching and Learning (SoTL) Leadership: The Scholarship of Teaching, Learning and Curriculum Practice in Research-Intensive University Contexts". I also attended two hands-on workshops related to use of the NUS learning platform IVLE: "Creating Surveys in IVLE" and "Assessing Student Learning Using IVLE". I was impressed by the number of offerings of such events (10 to 15 per month). I was also impressed by the level of the speakers, often external speakers. I was also impressed by the fact that NUS has a number of people employed at CDTL as "Principal Educational Technologist". Their role is not only to continue to contribute to development of the IVLE environment, but also to arrange regular hands-on workshops and go out to teaching staff to help them make best use of the teaching platform that is available. The latter inevitably lead me to draw unflattering comparisons with the support staff resources available for such purposes at Chalmers, who tend either to be teaching staff enthusiasts who are being paid to be available to help others but who never have time, or external consultants used to dealing with other types of users and who have really hard time understanding the real needs of academic teachers.

5 Reflection about significant differences between NUS and Chalmers

I have commented on a number of significant differences in the preceding sections, but for the sake of clarity these aspects will be repeated for the benefit of readers who choose to focus their reading on specific sections of this report.

A first major difference is that NUS has well-established routines for most activities, including accommodating guests. ChBE has several office rooms reserved for visitors. The help I received during

my planning trip in March was highly relevant and professional, as was all help in preparing the paperwork for my fellowship (application for staff housing, staff medical insurance, and employment pass, as well as the visiting professor contract). My office, computer account, email account, etc were ready when I arrived on August 1st, and most things worked immediately. The little that did not was put right very fast by helpful staff members. All IT equipment in lecture rooms worked always (0% failure in 4 months of teaching). More importantly, there is plenty of support staff available, so little teacher time is spent solving technical and administrative issues. All in all I got the clear impression that academic staff can focus more of their time on teaching and research because there are good IT support systems available and plenty of support staff to deal with administration. This is a major difference from Sweden, where far from perfect IT systems are installed on a regular basis, mainly with the objective of being able to reduce administrative staff and expect academic staff to their own administration in new and clumsy IT systems. Staff housing was available within easy walking distance from my office, and it is a matter of policy to provide staff housing for visiting faculty. I think that Sweden has much to learn from NUS in these regards.

A second major difference is student attitude. NUS students work very hard and take full responsibility for their studies. They read course material before lectures, and they work hard and independently at homework assignments. This is true of a number of students at Chalmers as well, but too many of our students adopt a passive attitude. They attend lectures without having opened the book beforehand. They turn up at in-class exercise sessions without having done any preparation, and sleepily demand detailed guidance from the exercise tutor without the slightest sense of embarrassment. And they nag teachers for old exam papers as a strategy for preparing exams instead of reading and understanding the teaching material provided. Not once at NUS was I asked to provide detailed information about what students could expect at the exam. Nor did NUS students go through their graded exam papers and aggressively insist on obtaining higher marks. Some students did approach me to request explanations of my grading, or to point out what they considered to be misunderstanding on my part. However, all such discussions were conducted in a polite manner, and they did insist aggressively if I refused to meet their demands. I found this extremely refreshing compared to the aggressive insistence of some students at Chalmers. NUS students were prompt to point out glitches in lecture slides, homework assignments and homework solutions, but it was always done politely and respectfully. On the negative side, I found NUS students to be rather passive (from my discussions with other teachers and students I concluded that this was a collective attribute of engineering students at NUS rather than a reaction to anything that I was doing or not doing). I was also sometimes a little surprised at their somewhat unpractical approach. They could get really hooked up on data provided in handout that was *very slightly* in conflict with other data provided in class, and not always know how to deal with the situation. This was particularly true during the mini-project, when I became at times frustrated with their unwillingness to make a reasonable assumption and move on, or come to me quickly to solve the conflict.

Regarding **use of technology**, NUS has a a well-functioning IT teaching platform (IVLE), offering many opportunities for using modern teaching methods (of which I sadly used virtually none other than the possibility to distribute documents electronically, send announcements to students and register assessment item grades). From my contacts with colleagues at CDTL workshops, I gathered that many teachers make use of functions such as electronic quizzes, monitored discussion forums, eval-

uations, etc. In this respect IVLE is better than the "home made" student portal with which I have worked for many years at Chalmers. However, it is my understanding that the learning platform Ping-Pong will offer similar functionality. One major advantage with IVLE was that it offered a single access for many relevant teaching functions. It was the main tool for entering the detailed class schedule (whereas Chalmers had a separate tool for scheduling). I could access the profile of all students registered in my module (including photograph, email address, list of other modules read by semester, etc). It was also the main tool to register grades of tests, quizzes, project assignments, etc. IVLE also allowed export of grade marks to IMMS, the official final grade administration platform. IMMS was equipped with automatic grade statistic handling. IMMS was a major improvement over the "stone-age" cumbersome grade handling program in Sweden (LADOK). Regarding technology, I was not aware of any full-scale distance learning activities, or co-teaching in collaboration with other universities using video-link or other forms of technology-assisted learning. I was aware of some teachers beginning to experiment with "Flip classroom" teaching (i.e. urging students to read teaching material, view slide shows, etc prior to lecture slots), and keep lecture slots for student-driven discussion rather than listening to a lecture. In this respect, I ran into a number of colleagues who share my sense of boredom and frustration with conventional "one-way" teaching, and who are beginning to use technology to explore newer methods. I had, however, expected to experience more of this type of activity in the department.

Regarding **attitudes towards teaching**, I am still a little confused. Teaching definitely has a higher status at NUS compared to Chalmers. All academic staff are expected to teach, regardless of rank. Teaching performance is taken very seriously when evaluating tenure applications (although the signals were clear that research performance is weighted more heavily than teaching performance). CDTL is in place and working hard at teaching practical teaching skills to junior staff members (note however that the numerous activities offered by CDTL are not mandatory for new staff members, only recommended; I received mixed signals about how much young faculty members actually attend these events, including tales of people signing up so as to be on the list of participants, but "forgetting" to actually show up). In this respect I think that Chalmers is correct in requiring that all young faculty attend a complete training package prior to applying for tenure.

Grading is taken very seriously, as is individual student performance follow-up. The department is now in the process of hiring teaching track faculty members, and there is active talk at faculty members about forthcoming change of policy as a result of which the best teachers will be allocated to first year student classes instead of final year and Postgraduate level classes. The department is active in international chemical engineering curriculum development boards, in collaboration with US, UK and Australian major accreditation institutions. In my mind, all of this should lead to a collective ardent interest for undergraduate teaching and learning. Yet I never really sensed this. Maybe the timing was wrong (curriculums are not revamped every month after all), or maybe a small group of enthusiasts that I did not identify does most of the work. All in all, I got a sense of a well-oiled machine taking in very gifted students, and putting them through an intense and well-planned but relatively traditional curriculum, with the help of a well-functioning student administration and professional IT support tools. I noted very few instances of new pedagogical methods being implemented on a wide-front (although I did of course get to meet with a number of enthusiastic colleagues experimenting with new methods).

6 Concluding remarks and action plan

My stay at NUS delivered what I had hoped for: an opportunity to teach gifted students in a very different environment than that I am used to at Chalmers. The experience has further reinforced my conviction that conventional teaching methods (lectures followed by labs and/or problem sessions) breeds student passivity which in turn leads to boredom for teachers. I had hoped to come further with experimentation of alternative methods, but I at least gained some ideas and had discussions with other teachers who are also struggling with this issue. I will most certainly continue and intensify such discussions when I return to Sweden, and make sure that I establish a network of supportive colleagues around me, within my Division and my Department. In this respect, the Learning Centre at Chalmers will constitute a priceless resource and I intend to make a clear effort to become involved in the activities that the Learning Centre offers, as well as the associated network of teachers interested in improving their teaching.

I also **hope and plan to return to NUS** within a few years. I have reflected a lot over the structure of the STINT XinT program, and discussed this with a number of XinT fellow colleagues as well as XinT contacts within the Provost's office at NUS. We all seem to agree that the 5 month timeframe is too short. It is a very short time to be in Singapore for families with children. And, more significantly, it only allows teachers to participate in teaching once, without any opportunities for iterative improvement. Also, teaching a module once only in a new environment inevitably results in significant stress, which results in adopting conventional teaching methods. These are the methods we and the students know and are comfortable with. Preparing teaching material (lecture slides, homework assignments, project assignments, test questions) is a full-time commitment when being conducted for the first time. I am fully convinced that it would be extremely beneficial for all parties involved (myself, Chalmers and NUS) if I were to be given the opportunity to return to NUS to teach the same module again. However, if I were to do so, it would be within the framework of a well-planned pedagogical project defined in cooperation with CDTL at NUS. I have discussed this idea with Prof Lakshminarayanan Samavedham, Director of CDTL, who is also a faculty member of the Dept of Chemical and Biomolecular Engineering at NUS, who gives his whole-hearted support. The focus of such a project would be to explore the teaching method literature and to identify specific ways to change the classroom roles so as to move away from the "one-way" lecture and "one-way" tutorial model. I would also like to explore more "hands-on" examination methods, centred on computerized exams in the form of "micro-projects" conducted individually in computer clusters. Similarly I would like to develop a number of tutorial problems based on "real life" like sets of data, instead of classical textbook type problems.

I leave NUS with a dream of coming back one day.

Simon Harvey, Singapore, December 14, 2012.