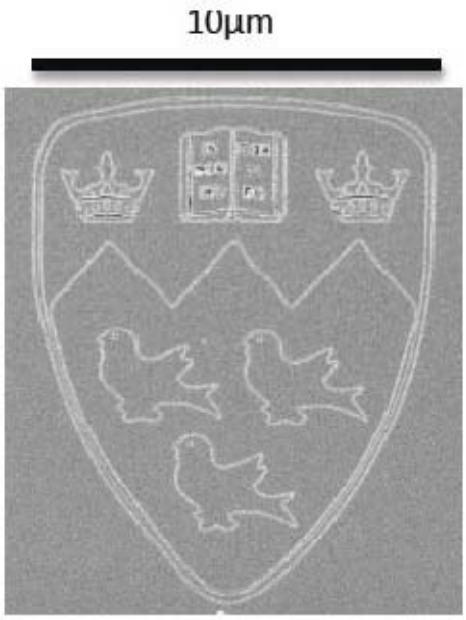
Nanotools MicroFabrication Facility

Annual Report

June 2010 – May 2011

Submitted June 1st, 2011

Prof. P. Grutter
Director,
Nanotools MicroFabrication Facility



Content

Executive Summary

Fiscal year 2010-2011 only lasted 11 months. Nevertheless, the income from user fees was $207,265 (an increase of 14% from 2009/10)! **For the first time since inception, the McGill Nanotools Microfab is recovering operating expenses from user fees.** The University continues to support the cost of manpower at 100%. Usage on a 12 month basis is 4% up compared to 2009/10 to 6900h (6300h in the 11 month fiscal year). There were 41 PIs using the Microfab, with 3 users using it for more than 1000 h, 11 more than 100 h, and 27 less than 100 h. A dramatic 50% increase in publications compared to last year is observed (57 papers, 6 patents in 2010/11). Industrially-linked research grants have increased from 8 to 10 and the number of graduated students with Microfab experience from 28 to 52. The PIs acquired a total sum of more than 2.7M$ (1.3 M$ in 2009/10) in *new* grants and contracts directly linked to the Microfab! Particularly noteworthy is a new NSERC CREATE in Neuroengineering (PI R.B. Lennox and 9 others), the second Microfab enabled CREATE grant after the one in Integrated Sensor Systems obtained by A. Kirk (PI) and 9 others in 2009/10. We thus expect the current income, usage and output to increase next year. We will need to increase the manpower in the Microfab to continue offering the same high level of services and equipment availability offered in the past year.

A clear trend is observable in all the data: the majority of users are from engineering, as is the research output. This is a reflection of the fact that only engineering has faculty members with an exclusive, major focus on microfabrication. For science and medicine faculty members, access to the Microfab is important and is in many cases crucial for their research; however, they are not major users in terms of time or money spent in the Microfab.

This all points to a more intensive use of the McGill Nanotools Microfab, which is clearly becoming central to many, mainly recently hired, faculty in Engineering, Science and Medicine. Our outside usage has also grown dramatically, in particular industrial usage (although this is mainly due to one company, Aerovirus). The collected data presented in this report shows that we also have many old and new companies using the McGill Nanotools Microfab. The trend observed in 2009/10 is continuing: most of these companies access the McGill Nanotools Microfab via collaborative mechanisms such as NSERC Strategic projects, CRD or in other partnership agreements with McGill researchers. We conclude that companies are interested in the whole 'package': PI, HQP and access to excellent facilities.

In 2010/11 the McGill Nanotools Microfab has upgraded its equipment with the addition of:

- A parylene coater (Specialty Coating Systems – Lab Coater)
- A vacuum oven for wafer priming and image reversal processes (Yield Engineering Systems)
- A contact aligner (OAI 200)
- A probe station with 4 micromanipulators (Micromanipulators Co., Inc.)
- A white light interferometer microscope (donated by Prof. Fujinaga, Faculty of Music)

After extensive consultation with the Microfab users, the Canon Stepper was dismantled in August 2010.

Organization

Academic Oversight

In November 2009, the position of Academic Microfab director was created. The academic Microfab director is responsible for:

- updating or creating policies
- supporting training and teaching opportunities
- enabling scientific and technological development
    1. Taking advantage of available expertise and capabilities (active/passive 'matchmaking')
    2. Identification of needs and what to do about it
    3. Coordination of capital equipment grants (CFI)
- developing in- and outreach initiatives
- ensuring financial stability of the Microfab
- evaluation of Microfab personal
- receiving and following up on suggestions and complaints about Microfab operations
- generate an annual report (accountability, transparency and information)

To achieve these goals, the academic director is supported by an Advisory Committee (AC). The AC provides feedback to the Microfab director, but has no executive decision power, which rests with the Microfab director.

Academic Microfab director:	Prof. Peter Grutter, Assoc. Dean of Res. & Grad. Ed. (Faculty of Science).
Advisory Committee:	Prof. David Juncker (Medicine)
	Prof. Thomas Szkopek (ECE)
	Prof. Srikar Vengallatore (Mech. Eng)
	Dr. M. Nannini (Fab manager)

Achievements and key improvements

In October 2010, we decided to retire our old reservation system and replaced it with a more sophisticated software suite. This suite was developed by microfab managers for microfabs, and has been adopted by a large number of microfabs, both small and large, in North America. What makes it even more attractive is that it is open source and actively maintained by the community, which guaranties its long term support and availability.

This system brought us the following key improvements and capabilities:

- Allows users to check whether equipment is available or in use by others
- Reports equipment problems and serious shutdown conditions
- Allows quick checks of the operational status of each piece of equipment and creates detailed reports of problem/shutdown conditions and their resolution.
- Optionally, collect and save run data during processing.
- Maintains lists of qualified users on each piece of equipment.
- Allows certain users to have special privileges on specific pieces of equipment.
- Generates detailed laboratory usage information including equipment reservations, equipment usage, staff and training activities, and equipment problems and shutdown condition. It thus provides key data for billing and effective management of the facility. .
- Specifies the projects that each user is approved to work on, and the account corresponding to that project.
- Subscription to monthly charged services such as storage locker facilities, monthly cardkey access charges, etc.
- Provides an option to interlock equipmentOffers a reporting engine that supports online (html/xml), Excel, and PDF formats. Additionally, flexible role-based report access is supported to manage and control information available to users.

The annual Microfab user meeting was held 15 April 2011 with more than 50 participants. The keynote speaker was Prof. L. Frechette (Sherbrooke), who spoke on 'Creating a continuum for innovation in microtechnology'. This was followed by open discussions with the Microfab users on issues concerning operation and equipment. . In particular, the need for new tools, and the possibility of acquiring these tools in the upcoming CFI VI were discussed. A poster session was also organized, and the award for the best poster was presented to H. Nguyen.

The aim of these meetings is to build and sustain the Microfab community, facilitate personal interactions, enable the exchange of information, and provide a forum for consultation between the Microfab team and users. Policies and procedures are discussed (and if necessary subsequently adapted).

The 4th installment of the Hands-on Nanobiotechnology lecture and lab course war offered from February 21-25, 2011. This year's course drew 26 participants from as far as Greece, including 3 faculty members from McGill and the University of Ottawa, and 1 participant from Industry (Teledyne DALSA). Participants received basic instruction on microfabrication and each made their own wafers in the clean room. Microfluidic techniques and microcontact printing were demonstrated in the lab, as well as brainstorming sessions to help them design devices specific for their research. http://micronano.info has more details.

In 2010/11 the following new policies were developed, communicated and implemented. The general philosophy guiding these policies is to provide transparent and fair access to all users (major and casual, academic and industrial) and to nurture the vision of a shared, safe Microfab community where all users share responsibility, information and training.

- New user fee structure ($50 per hour; capping of TMAH etch, acid bench use at $50)
- After hour access to Microfab (buddy system, no HF, OK from fab staff)
- Consequences for not signing in for using equipment.

A new public web site matching the look-and-feel of McGill theme was implemented by the Microfab manager. The Microfab manager also initiated the acquisition of a TV screen, strategically positioned in the lobby of Rutherford Physics, to advertise the facility.. This screen is shared with the Physics Department.

Finally, an annual evaluation of all Microfab staff was performed. The process consists of a self-evaluation followed by an evaluation by the supervisor, as specified in the job description.

The Microfab manager is evaluated by the academic Microfab director; all staff members of this facility are evaluated by the Microfab manager. Reappointment of all staff was recommended. The manager and staff form a highly motivated, dynamic and hard working group.

All the initiatives listed above were a joint effort by the AC and the Microfab operation staff, in particular the Microfab Manager.

Major new policies

1. Fee structure:

The current pricing structure is as follows (updated June 1st 2010 and March 1st 2011):

1. The **Facility Fee is 50 $/hour** (was increased on June 1, 2010 to achieve a balanced operating cost budget**)**.

2. Starting April 2011 onwards, **the cost of the TMAH bench, the two acid benches and the Blue Fisher Oven will be capped to 50$ if used more than one hour**.

3. **A 15% consumable surcharge** is be added to Facility Fees **on equipment requiring consumables**. (e.g. photo resist, sputtering tool, etc).

4. **$ 1.50 per nm of deposited precious metal** (Au, Pd, Pt) is charged instead of the usual 15% consumable surcharge. This applies to the ebeam evaporator and the sputterer and is adjusted to the cost involved in buying the precious metal target.

5**. Soft Cap:**
The new pricing structure is based on a single hourly base-rate per student:

1. **Single PI/ 1-3 students** –For each student (1-3), the PI will be charged the full Facility Fee for the first 25 hours of the month. For subsequent use, each hour will be charged at 25% of the Facility Fee for the remainder of the month.
2. **Single PI / 4 students or more** - For PIs with 4 or more students working in the fab the PI will be charged the full Facility Fee for the first 50 hours logged collectively by all his/her students per month. For subsequent use, each hour will be charged at 25% of the Facility Fee for the remainder of the month.

Note that the number of students per PI is defined as the number of students who used the Microfab in a given month.

6. **Industrial users:**
The Facility Fee for **industrial users** is $100/hour plus consumables and the McGill overhead charges.

As in the past, we will have to continue to charge a 1.5% overhead on all bills (this is clawed back by the Provost).

Billing periods:
There are 12 billing periods per year (monthly billing).

The new pricing applies to all academic users (McGill or non-McGill). Any other additional service such as technical support, engineering etc. is invoiced at an hourly rate of $60.

2. Fab misuse – penalties for breaking the rules:

With increased usage, the policy with respect to non-adherence to rules pertaining to safety, environment, tool mistreatment or usage of tools without signing in to CORAL (upon which billing is based) needed to be applied. Observed infractions include equipment mishandling (e.g. leaving resist residues in the spin coater or ramping up the voltage too fast on the ebeam writer), safety (e.g. safety equipment not worn or bottles not labeled), environment (disposal of acids and solvents!) or after-hours usage of equipment.

If a serious infraction is discovered (e.g. via random checks of video surveillance tapes), the Microfab manager discusses the issue with the users and the Microfab director. The aim is to initiate a change of behavior. In addition, the following rules apply without exception:

- Suspension of access for two weeks for 'basic' infractions, as decided by the Microfab. Director (after talking to all the parties involved).
- Suspension of access for four weeks if there is a major impact on other users (e.g. down time of a crucial tool). In 'major' cases, it is the committee that makes the decision after due process (i.e. talking to all parties involved with the aim of ensuring that the rule breaker was correctly identified). Safety and environment are major offenses.
- Repeat offense leads to a doubling of the suspension time.
- Public announcement of penalty for offense as deterrent. (posted on the Microfab user list without name of offender)
-

Update on Manpower and Equipment

Operation Staff

Microfab Manager: Dr. Matthieu Nannini

Technologist: Don Berry

Pierre Huet (not renewed end of June, 2010)

Equipment technologist

John Li (hired in June 2010)

Research Assistant

Lino Eugene (hired March 2011)

Changes in Tools

The following piece of equipment was deemed obsolete by the community and has been removed:

- Canon Stepper – dismantled in August 2010

The following pieces of new equipment were purchased and commissioned in 2010-2011:

- A parylene coater (Specialty Coating Systems – Lab Coater)
- A vacuum oven for wafer priming and image reversal processes (Yield Engineering Systems)
- A contact aligner (OAI 200)
- A probe station with 4 micromanipulators (Micromanipulators Co., Inc.) and a semiconductor parameter analyzer (HP, used)
- A white light interferometer microscope (donation)

Outcomes: Publications, HQP and Grants

Summary

Nearly all outputs quantifiable with reasonable effort show a dramatic increase as compared to previous years. 91 students worked in the Microfab (64 in 09/10), 57 publications (41 in 09/10), 6 patents (2 in 09/10), 52 HQP graduated with a project that had a major Microfab component (28 in 09/10) and 3 external companies used the Microfab (8 in 09/10).

Publications (including Patents and Disclosures)

In 2010/11, at least 63 peer reviewed publications and 6 issued or filed patents resulted from work with an intensive Microfab component (some of the minor Microfab users did not provide an annual report). This is a major increase compared to 41/2 in 09/10 and 21/7 in 08/09 for publications/patents. Appendix A gives the detailed titles, authors and references.

Graduated HQP

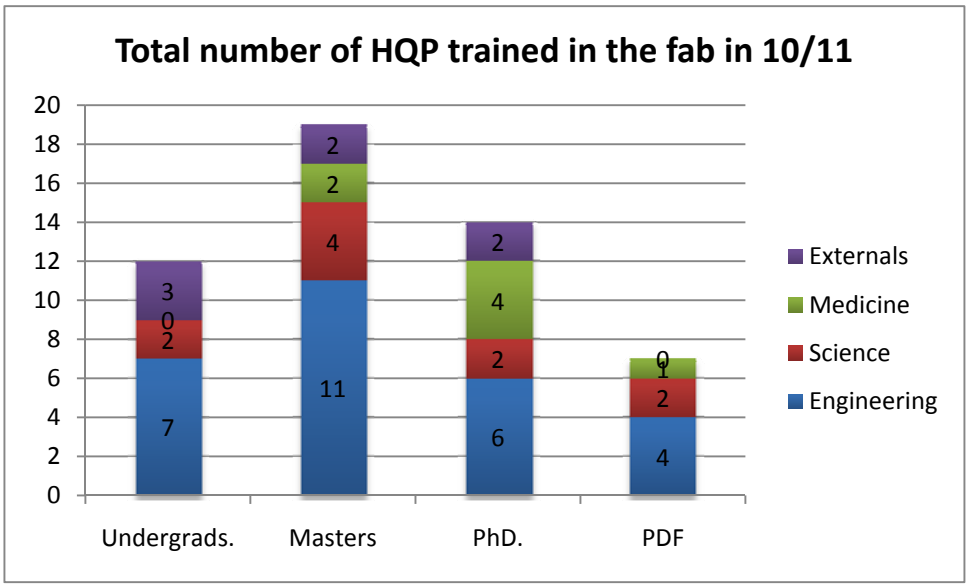
The total number of HQP trained in the Microfab has continuously increased from 57 (2008/09), 64 in 2009/10 to 91 in 2010/11. What is remarkable is the large number of students who graduated with a major component of their work being performed in the Microfab (see appendix for details). Again, these numbers are underestimates, as not all PIs provided a report, and they are reported with the affiliations in brackets as follows:

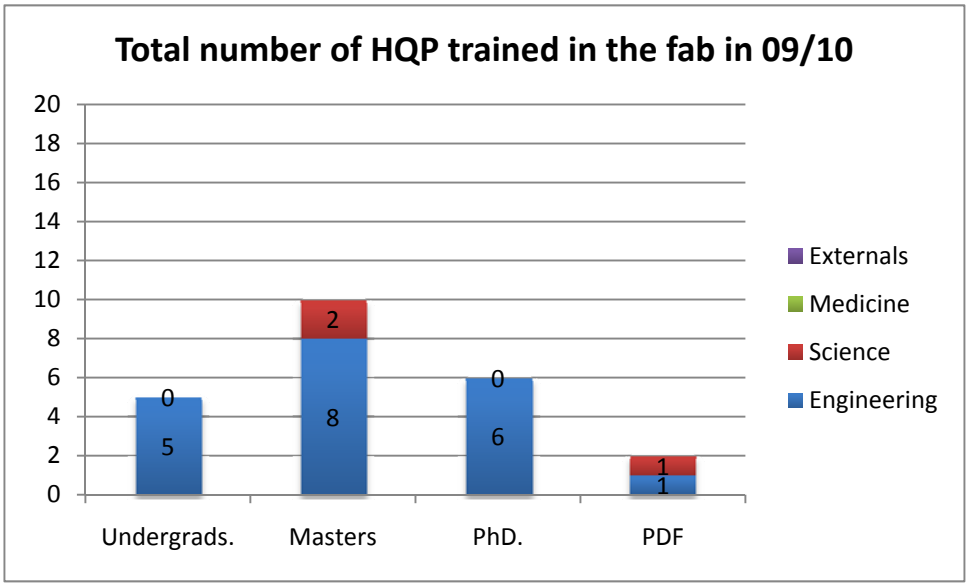
Student category	2010/11	2009/10 *(#engineering-#science-#medicine-#externals*)
Undergraduates	12 (7-2-0-3)	5 (5-0-0-0)
Masters	19 (11-4-2-2)	10 (8-2-0-0)
Ph.D.	14 (6-2-4-2)	6 (6-0-0-0)
PDF	7 (4-2-1-0)	2 (1-1-0-0)

Research Grants acquired due to access to fab

The total of ***new*** grants and contracts directly linked to the fab had a value of **$ 2,669,150** - an increase of more than 100% from $ 1,339,826 in 2009-10**.** The distribution across faculties is more even, in contrast to 2009/10, when the PIs of these grants were almost exclusively from the faculty of engineering.

The biggest and most important success for the Microfab was the NSERC CREATE Training Program in Neuroengineering, ledby R.B. Lennox (PI) and 9 others, including members from science, engineering and medicine. This training grant is worth $1,650,000 (2011-2017) and is expected to fund graduate students starting fall 2011. Note that this is the second NSERC CREATE linked to the Microfab after last year's successful NSERC CREATE in Integrated Sensor Systems, led by A. Kirk (PI) and 9 others, including members from INRS, Ecole Polytechnique and Sherbrooke.





Budgetary report

Fiscal year 2011: June, 1st 2010 to April 30th, 2011

(note: 11 month due to change in budget cycle)

Summary:

Quarter	Total expenses	Total invoiced	Difference
Q1	33 772.40 $	59 734.03$	+25 961.63$
Q2	42 781.49 $	48 902.76$	+6 121.27$
Q3	36 125.16 $	61 022.09$	+24 896.93$
Q4	68 452.53 $	37 606.42$	-30 846.11$
Total	181 131.58 $	207 265.31$	+26 133.72$

History

	Total expenses	Total invoiced	Difference
FY08	137 038.35 $	83 184.13 $	- 53 854.22 $
FY09	115 529.12 $	77 432.85 $	- 38 096.19 $
FY10	147 748.18 $	140 843.08 $	- 6 905.10 $
FY11 (11 months)	181 131.58 $	207 265.31$	+26 133.72$

Expenses Details for FY11

	$$	FY11	FY10	FY09	FY08
PM-Repair: includes equipment and facilities repair expenses	76 065.40 $	42.0%	42%	51.8%	60.9%
Consumables: includes chemicals (acids, solvents, litho…), materials, substrates, …	75 062.25 $	41.4%	38%	40.5%	25.6%
Purchase: small tools, fab improvements, MDEIE installs	13 789.18 $	7.6%	5%	1.8%	8.8%
Office: includes NCS charges, computer and office supplies	12 591.70 $	7.0%	10%	5.3%	2.5%
Clients: includes expenses for clients when subcontracting is needed	932.96 $	0.5%	4%	0.3%	0%
Travel	1 856.82 $	1.0%	5%	-	-
External: work done in other core facilities	683.69 $	0.4%	1%	0.3%	1.6%
Uncategorized	149.58 $	0.1%	1%	0%	0%

Comments:

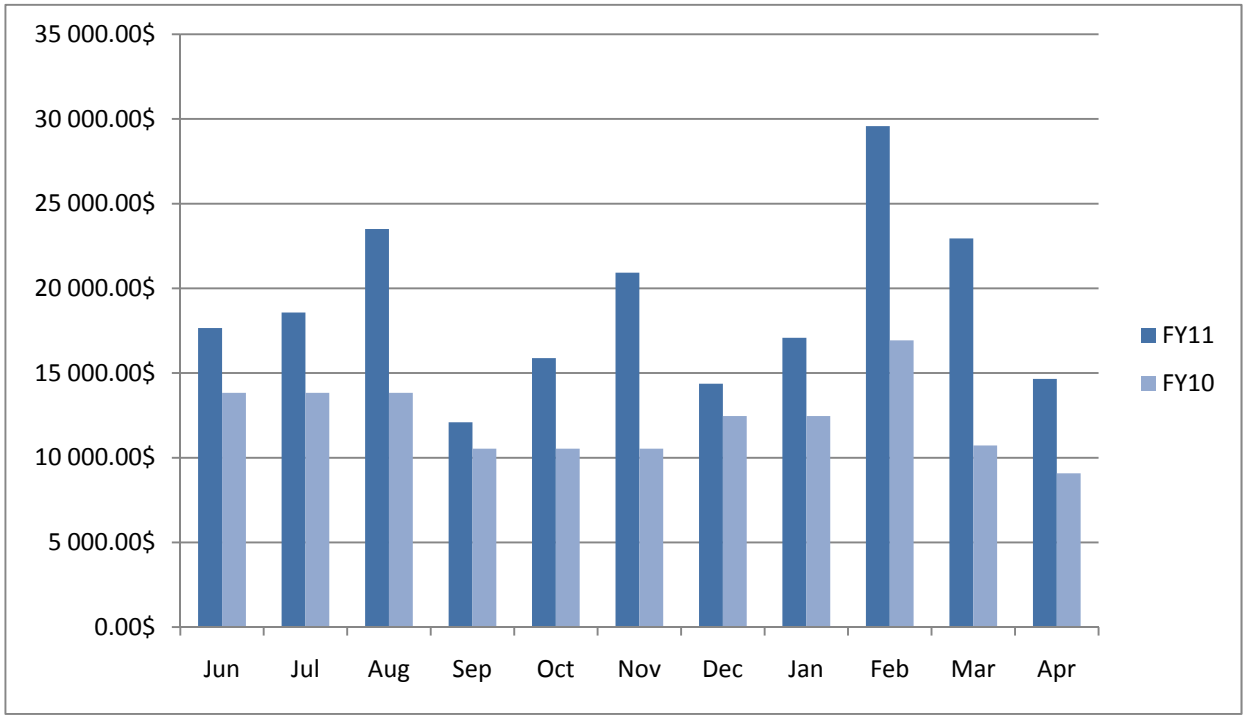
- We purchased probes and a semiconductor parameter analyzer to go along with the probe station as well as a chemical resistant hotplate, individual pumps and several others small items.

Revenues

Reminder: as of February 1st, 2010, Microfab fees were set to 40$/h regardless of equipment used. This was increased to 50$/h starting June 1st of 2010. In addition, a soft cap (instead of the previous hard cap) was implemented. Details can be found at http://miam2.physics.mcgill.ca/?q=content/rates

Total revenues from June-10 to May-11: $ 207, 265.31

The following chart summarizes revenues for the FY 2010/11 (Total number of PIs 42):



Comments

Although the rates increased substantially in the past 14 months, usage increased and revenues also increased by 14%. User fees now cover the operating cost of the Microfab.

Usage

In 2010/11 the Microfab generated more than 6300 billable hours (note, the 2010/11 fiscal year had 11 months only). Prorated to 12 months, this would correspond to close to 6900h, a slight 4% increase over last year. In 2008/09 we had a little more than 2300 billable hours. We have sustained the number of major users (defined as PIs who use the Microfab more than 100 h per year) despite the substantial increase in the rate charge per hour and the removal of a hard cap. We now have 11 major users, including 3 users with more than 1000h! This demonstrates that the user base of the Microfab is now broad and sustainable. These 42 PIs sent a total of 91 HQP to work in the Microfab, compared to 64 in FY 2009/10 and 57 in FY 2008/09 – a 28% increase. On average, each HQP spent nearly 76 h in the Microfab.

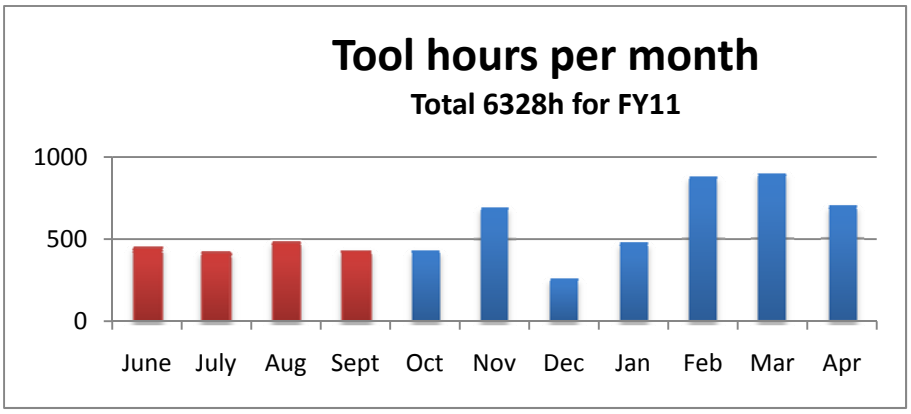


Figure 1 Billed hours per month in FY 2010/11. Blue shows the transition to an automated signing in system (CORAL) and a different accounting system.

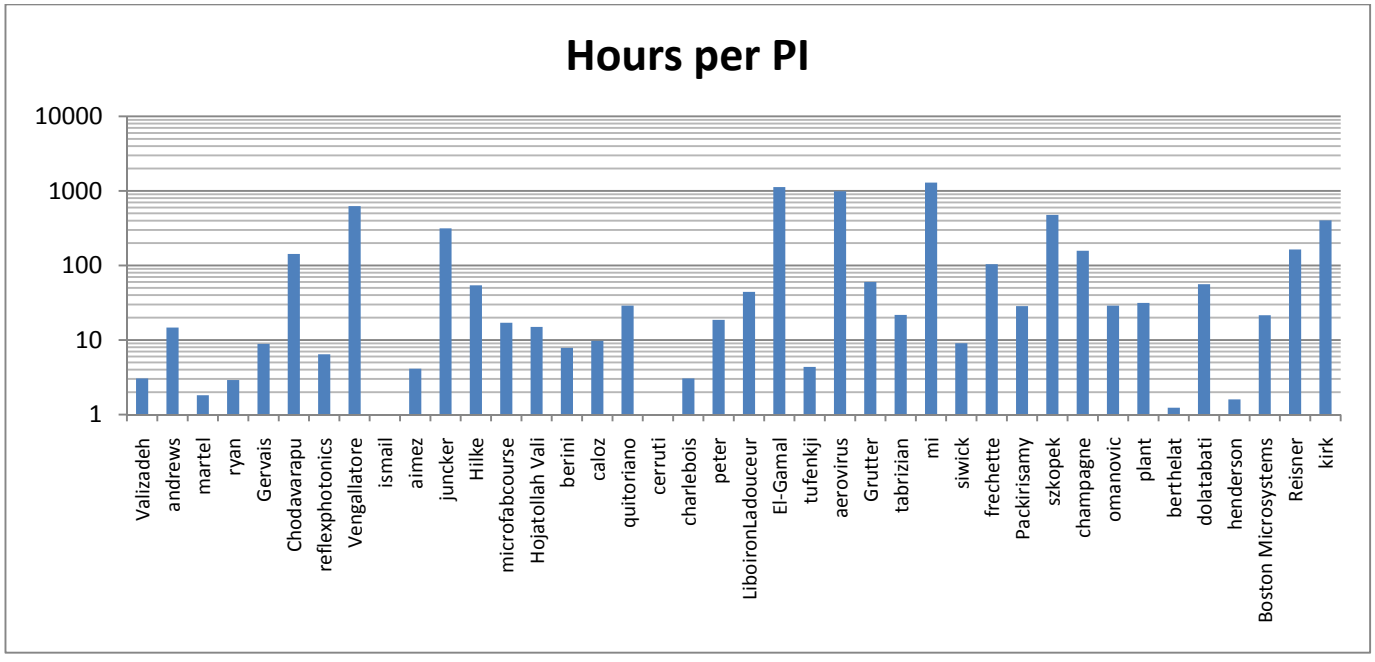
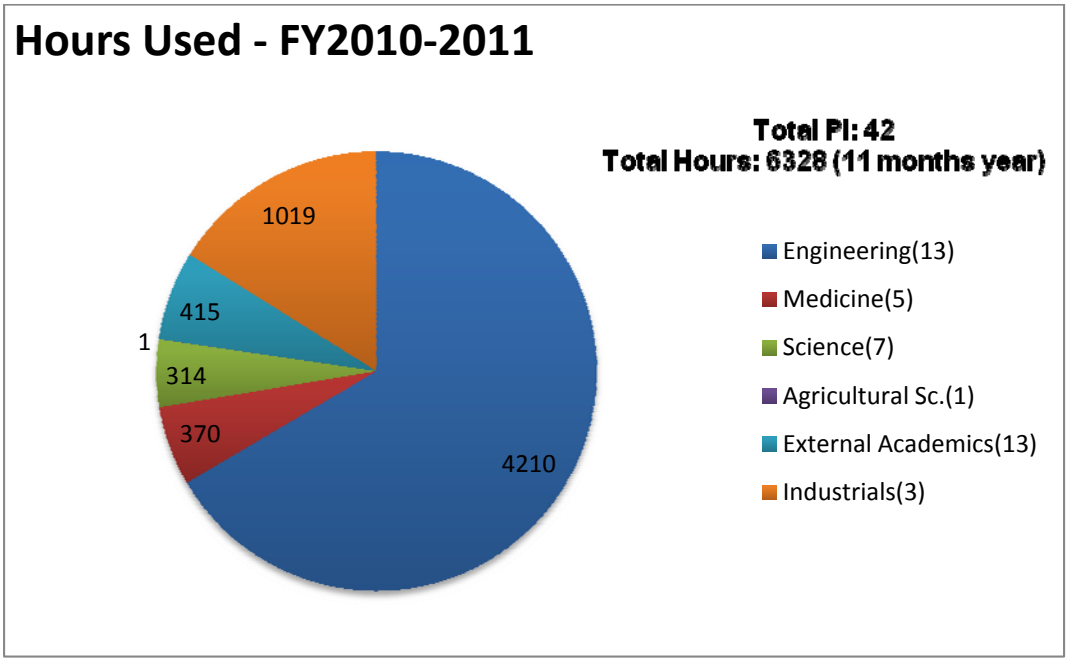


Figure 2 Total hours per PI for FY 2009/10. Note the broad, sustainable basis of major users with more than 100h.

Usage breakdown according to faculties:

The major user in terms of hours is the faculty of Engineering. Medicine, Science and external users are similar, each about 10-20% of the usage by engineering. Major increases in usage were observed for industrial users (due mainly to Aerovirus Technologies). Engineering usage was slightly reduced (10% on a 12 month basis) due to completion of several major projects. The total number of PIs increased by 20%, mainly due to members from Engineering. Despite the rate increase, the number of external users has remained constant.



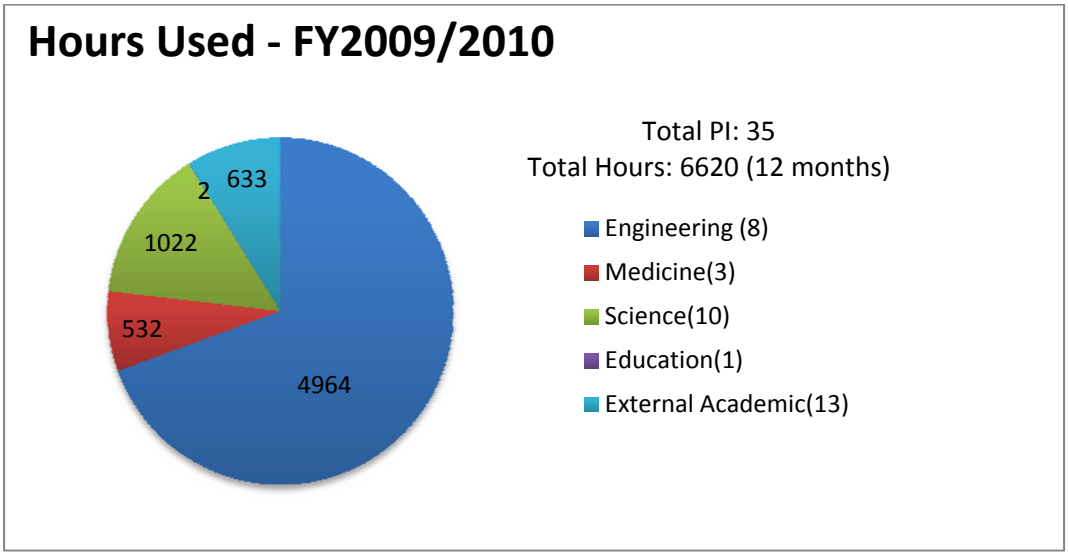
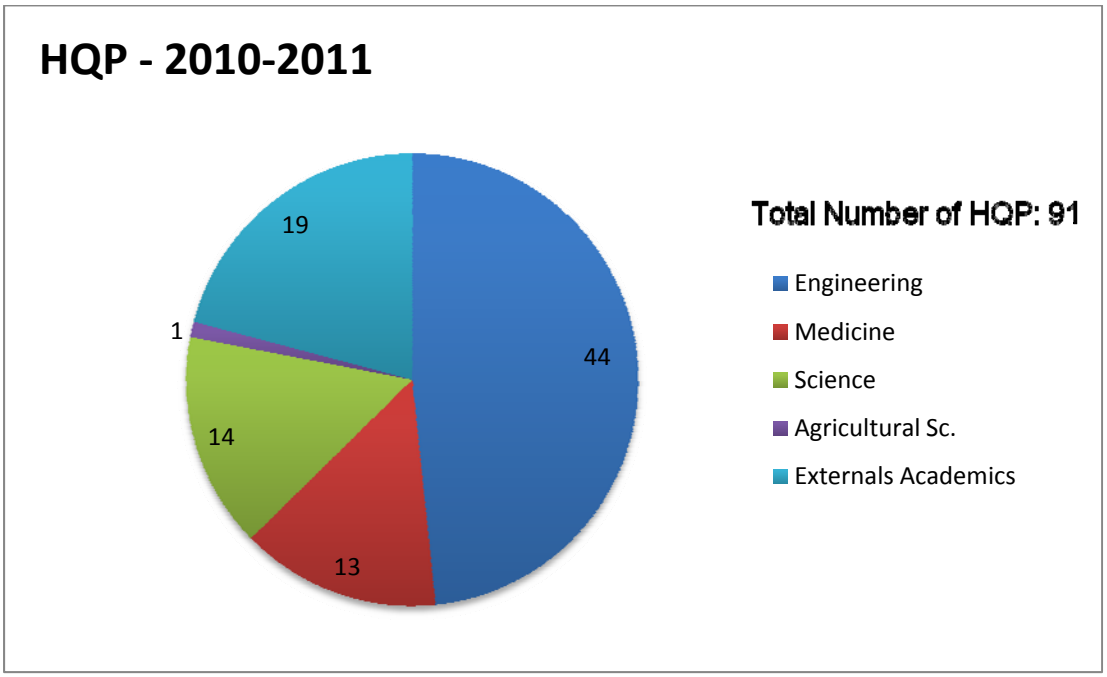


Figure 3: Breakdown of hours of Microfab facility usage for fiscal years 2010/2011 and 2009/2010. The number of principal investigators (PIs) for each category is also given in brackets. PIs affiliated with the Faculties of Engineering are major users, with Medicine, Science and external industrial usage also noteworthy.

The total number of HQP trained in the Microfab increased by 42% to 91, essentially due to a larger number of engineering students.

It is noteworthy that for a 239 workday year, assuming an 8 hour day and a total of 6900 h billed hours (on a 12 month basis), **on average there are 3.6 HQP in the Microfab at all the times**. This translates to 4 different processes being executed on a given day in the Microfab, a major challenge in terms of support and scheduling of equipment.



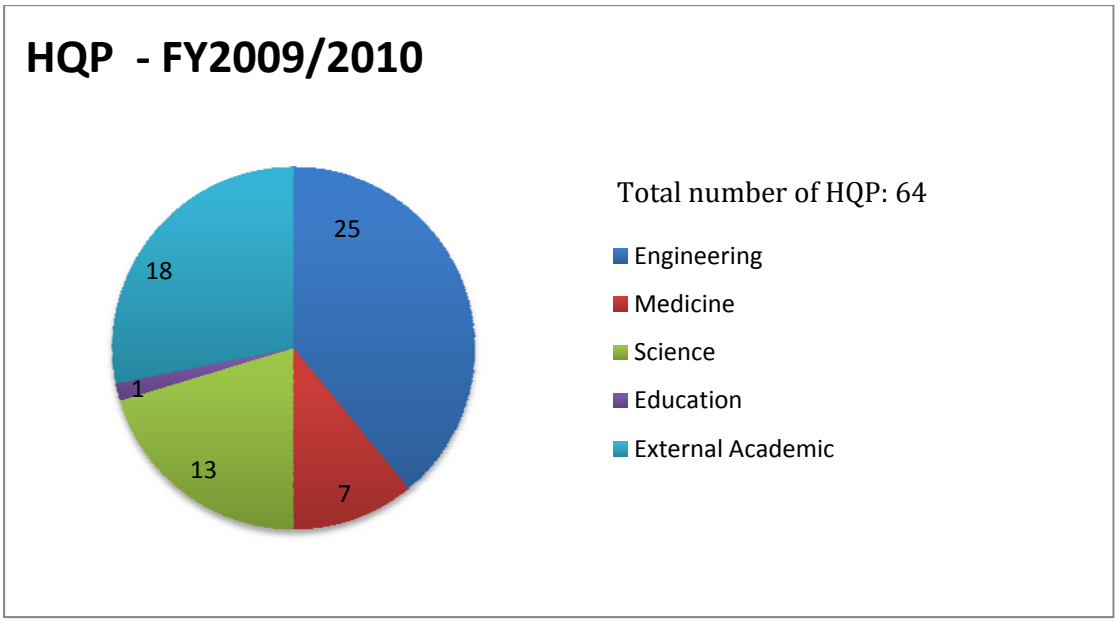


Figure 4: Number of HQP using the Fab for fiscal years 2008/2009 and 2009/2010, broken down by Faculty affiliation. There has been a 12% increase in HQP using the Fab in the last fiscal year.

Industrial Usage:

We observed that companies are not very interested in directly accessing the Microfab. A strong increase in academia-industry collaborations and partnerships leads to the conclusion that companies prefer to access the McGill Nanotools Microfab via collaborative mechanisms such as NSERC Strategic projects or in other partnership agreements with McGill researchers instead of directly using it. This is corroborated by informal and non-representative discussions with several companies: they are interested in the whole 'package': PI, HQP and access to excellent facilities. In one case (Boston Microsystems) the attractive cost structure and the availability of a unique tool (spray coater), as compared to Microfabs in the Boston area, was an important factor in deciding to engage in a collaboration at McGill.

The following companies have used the Microfab in 2010/11: (collaborating PI indicated in brackets)

Aerovirus Technologies (Ste Hyacinthe QC) has a research contract with the fab to develop a prototype.

MEMS-Vision Inc. is a spin-off company from McGill (Mourad El-Gamal).

Boston Microsystems (Research collaboration, Srikar Vengallatore,)

General Motors of Canada, Inc. (Strategic Grant and Collaborative Research Grant, both S. Vengallatore in collaboration with Prof. Luc Frechette at Universite de Sherbrooke. The combined value of these grants is about $1 million over four years (2008-2011)

General Motors of Canada, Inc. (M. Cerruti and T. Szkopek) NSERC CRD entitled 'Graphene-Sn nanocomposites for Li-ion battery anodes' with $19,130 cash and $25,910 in-kind support from GM.

Bombardier and Thales (industrial sponsors of a CRIAQ project entitled "Data Networks and Smart Sensors for Safety-Critical Avionics Applications". Mourad El-Gamal)

Reflex Photonics Inc. (Montreal) committed in-kind support for NSERC Strategic grant entitled 'Direct integration of microtube lasers on silicon' (PI Andrew Kirk, with Z Mi and D.V. Plant), $136,000 per year of funding from NSERC (2009-2011)

DALSA Semiconductor (Bromont) has committed $20,000 per year of funding as part of a NanoQuebec project entitled 'Integrated polymer electro-optic switches', (PI Andrew Kirk, with Mark Andrews), leveraging $66,667 per year of funding from NanoQuebec (2010-2012)

ICP Solar Technologies and Silonex Inc.
'Full-Solar-Spectrum InGaN Tandem Solar Cells on Si' (Z. Mi)

DNA LandMarks Inc.
'Ultrasensitive InN Nanowire Biosensors' (Z. Mi, P. Grutter, R. Sladek)

Outside, non-academic users:

Similar to industrial users, several organizations sponsor applied research with a strong fab component:

Canadian Space Agency and NanoQuebec.
'CMOS integrated Nitride Nanowire Array Based Bacterial Nanosensor' (V.P. Chodavarapu and 3 others). 2009-2011 for $261,000.

Sandia National Laboratories (USA):
'Nanoelectronics Experiments Using Coulomb Drag to Study Coupled One-Dimensional'
(G. Gervais, US$ 22,068)

Genome Québec
'Towards a Portable and Fully Automated SPR-Based Digital Microfluidics Array Platform Integrating Diffractive Optical Elements for Genomics and Proteomics' (M. Tabrizian & 2 others, $133,333 p.a.)

Canadian Institute for Photonic Innovations
'Nanoporous silicon catheter device with real-time optical monitoring of bacterial contaminants during hemodialysis', V.P. Chodavarapu (PI) and 1 other, $31,900

Defence Research and Development Canada
'Antimony-Based Long Wavelength Self-Organized Quantum Dot Lasers Alternative Energy: Solar-to-Hydrogen' (Z. Mi and H. Guo, $ 110,000)

Organizations with which the fab has had service agreements in the past 3 years are:

INO (Quebec City), Semiconductor Insights (Ottawa), Microbridge (Ottawa), Reflex Photonics (Montreal), Acculine Micro (Vermont). The Microfab was used mainly for proof of principle demonstration. Once established, processes were transferred to the clients, usually by the clients.

Outlook

Although the FY11 ended with a positive balance, the financial viability of the microfab is not guaranteed in the years to come. To achieve this we have defined several objectives:

1. **Manpower Funding**: increase the level of external funding through grant applications to Nanoquebec and NSERC MRS.
2. **Usage**: increase the level of usage by increasing outreach efforts to the community and possibly hire a business development person to attract more external users.
3. **Equipment**: apply to CFI VII for the upgrade of our toolset in order to stay competitive and state-of-the-art in the area of microfabrication.
4. **Operations**: improve microfab operations at the administration, tool maintenance and training level in terms of efficiency and effectiveness.

Appendices

Papers 2010-2011 that used some aspect of the McGill Microfab:

1. Integrated microfluidic probe station
C. M. Perrault, M. A. Qasaimeh, T. Brastaviceanu, K. Anderson, Y. Kabakibo and D. Juncker
Review of Scientific Instruments 81 115107 (2010)

2. Microfluidic perfusion system for culturing and imaging yeast cells microarrays and rapidly exchanging media
M. Mirzaei, M. Pla-Roca, R. Safavieh, E. Nazarova, M. Safavieh, H. Li, J. Vogel, and D. Juncker
Lab on a Chip 10, 2449 - 2457 (2010)
3. Addressable nanowell arrays formed using reversibly sealable hybrid elastomer-metal stencils
Mateu Pla-Roca, Rym Feriel Leulmi, Haig Djambazian, Saravanan Sundararajan and David Juncker
Analytical Chemistry, 82 3848–3855 (2010),

4. Straight SU-8 Pins
Roozbeh Safavieh, Mateu Pla Roca, Mohammad Qasaimeh, Maryam Mirzaei and David Juncker
J. Micromech. Microeng. 20 055001 (2010)

5. Wet-etching of structures with straight facets and adjustable taper into glass substrates
Nikola Pekas, Qing Zhang, Matthieu Nannini, and David Juncker
Lab Chip 10, 494 - 498 (2010)
6. Chamber and Microfluidic Probe for Microperfusion of Organotypic Brain Slices
Arthur Queval, Nageswara R. Ghattamaneni, Cecile M Perrault, Raminder Gill, Maryam Mirzaei, R. Anne McKinney and David Juncker
Lab Chip, 10, 326 - 334 (2010)

7. The Microfluidic Probe: Operation and Use for Localized Surface Processing.
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E. Ledwosinska and T. Szkopek,
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S. A. Imam, S. Sabri and T. Szkopek,
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F. Nabki, T. A. Dusatko, S. Vengallatore, and M. N. El-Gamal,
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Nabki, K. Allidina, F. Ahmad, P.-V. Cicek, and M. N. El-Gamal,
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Z. Mi,
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52. Metamorphic InGaAs/GaAs quantum dot lasers
Z. Mi, J. Yang, and P. Bhattacharya,
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53. Photoluminescence properties of a nearly intrinsic single InN nanowire
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54. Highly stable resistive switching on monocrystalline ZnO

A. Shih, W. Zhou, J. Qiu, H.-J. Yang, S. Chen. Z. Mi, and I. Shih,
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55. Controlled transfer of single rolled-up InGaAs/GaAs quantum dot microtube ring resonators using optical fiber abrupt tapers
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Y.-L. Chang, F. Li, and Z. Mi,
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Patents:

Lateral Growth Semiconductor method and devices
N. Quitoriano,
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Localized Multiple Measurand Solid State Brain Probe,
M. Hajj-Hassan, V. P. Chodavarapu, and S. Musallam,
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Method for Optimizing the Signal to Noise Ratio of Optical Beam Deflection Systems and Apparatus Thereof
A. Labuda, P. Grutter
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Low temperature ceramic microelectromechanical structures,
F. Nabki, T. Dusatko, M. N. El-Gamal, and S. Vengallatore,
US Patent Application, 12/341,013, June 2010.

Direct contact heat control of micro structures
F. Nabki, T. Dusatko, and M.N. El-Gamal,
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Low-temperature wafer level processing for MEMS devices
D. Lemoine, P.-V. Cicek, F. Nabki, and M. N. El-Gamal,
US Patent Application, September 2010.

Graduated HQP:

1. Name of undergraduates who used the fab:

Engineering:

1. Wang, Songzhe (Kirk)

2. Jerome LeBoeuf (Nate Quitoriano)

3. Alexandre Horth (Nate Quitoriano)

4. Andrew O'Reilly (Nate Quitoriano)

5. Tejas Desphande, (Szkopek), joined Painter's group at Caltech

6. Amir Mohsen Aliakbar: M. Eng., Electrical and Computer Engineering, (V. Chodavarapu)

7. Adrien Pierre, ECE, now a PhD student at University of California at Berkeley (Z. Mi)

Science:

1. Eric Whiteway (Hilke)

2. Mathieu Massicotte (Hilke)

External:

1. Étienne Léveillé, undergraduate student, graduate student UdeS (L. Frechette)

2. James Porter, B.Sc. in Physics at Concordia, (A. Champagne)

3. Roopak Singh, B.Sc. in Physics at Concordia (A. Champagne)

2. Name of graduated M.Sc.

Engineering:

1. Behnam Benan - Graduate researcher visiting from KTH University (Sweden)

Since Jan. 2011, Mr. Benan is a PhD candidate within the department of electrical and computer engineering at McGill University under Odile Liboiron-Ladouceur's sole supervision

2. Taslimi, Shahrzad (Kirk)

3. Chris Rodenchuk (MEng) (Szkopek)

4. Jonathan Guillemette (MSc) (Szkopek)

5. Mohamad Hajj-Hassan: PhD., Electrical and Computer Engineering, April 2010 (V. Chodavarapu)

6. Ahmed Korayem: visiting undergrad from U. Pierre&Marie Curie, Paris (F) (El-Gamal)

7. Galen Church: ECE (El-Gamal)

8. Hamza Bari: ECE (El-Gamal)

9. Nazih Jamal Eddine El-Gamal, co-supervised with Prof. F. Nabki, UQAM.

10. A. Bonsi, "Fatigue of piezoelectric beams used for vibration energy harvesting," M.Eng. Thesis, Department of Mechanical Engineering, McGill University (2010) (Vengallatore)

11. Chenxu Shao (Z. Mi, co-supervised with Gervais)

Science:

1. Chenxu Shao (working on his M.Sc with Gervais, co-supervised with Mi)

2. Benjamin Schmidt (transferring to Ph.D. with Gervais)

3. Guillaume Dauphinais (working on his M.Sc with Gervais)

4. Victor Yu: MSc 2010 "Graphene Monolayers on Various Substrates: Optics and CVD growth" (Hilke)

Medicine:

1. Setareh Ghorbanian, PhD student, UofT (Juncker)

2. Sebastien Ricoult, (PhD student Juncker)

External:

1. Serap Yigen, M.Sc. at Concordia graduated in Dec 2010, thesis title:"Heat transport in

graphene", currently a Ph.D. student with A. Champagne

2. Annabelle Gascon, M.Sc. (now at Dalsa) (Y.-A. Peter)

3. Name of graduated Ph.D.

Engineering:

1. Yongyuan (Alex) Zang (Plant)

2. Ebrahim Ghafer-Zadeh: Post-Doctoral Fellow, Electrical and Computer Engineering (V. Chodavarapu)

3. Hieu P. T. Nguyen (Mi)

4. Shaofei Zhang (Mi)

5. Xueguang Han (Mi)

6. Md Golam Kibria (Mi)

Science:

1. Chris Payette: PhD 2010 "Transport in weakly coupled vertical double quantum dots: Single-particle energy level spectroscopy and hyperfine interaction effects" (Hilke)

2. Shawn Fostner (now PDF in Christchurch, Nz) (Grutter)

Medicine:

1. Xuyen Hoa and

2. Lidija Malic both working at IMI-NRC (Boucherville-QC) (Maryam Tabrizian)

3. Tohid Fatanat-Didar and

4. Amir Foudeh (Maryam Tabrizian)

External:

1. Selin Arslan, PhD student, teaching, Michigan Tech University, USA (L. Frechette)

2. Katie Pitts, University of Ottawa,Chemical Eng.Dep. (CMC award) (Marianne Fenech, U. Ottawa)

4. Name of graduated PDF/technicians/others

Engineering:

1. Kai Cui (Mi)

2. Pablo Bianucci (Mi)

3. Saeed Fathololoumi (Mi)

4. Binxin Wu (Mi)

Science:

1. Binxin Wu (Gervais)

2. Josianne Lefebvre (Hilke)

Medicine:

1. Arghavan Shabani (PDF) (Maryam Tabrizian)

Grants and contracts:

The total of ***new*** grants and contracts directly linked to the fab had a value of **$ 2,784,308 in 2010/11** (compared to $ 1,339,826 in 2009-10). This is a substantial increase of more than 100%.
Note: all $ values indicated are per year.

NSERC:

NSERC CREATE training program in Integrated Sensor Systems
Kirk, A.G. (PI) and 9 others (CREATE)
Industrial engagement with IBM, DALSA Semiconductor, Perkin Elmer and several other companies via participation of Master's students in internships
$ 300,000

NSERC CREATE Training Program in Neuroengineering
Bruce Lennox & 8 co-applicants
$300,000

Data Networks and Smart Sensors for Safety-Critical Avionics Applications
Mohamad Sawan, Mourad El-Gamal, and 6 others.
Industrial Partners: Thales Avionics Canada Inc. & Bombardier Inc.
NSERC/CRIAQ Collaborative Research and Development Grant
Amount Total: $960,000
$57,250 El-Gamal's Share

Direct integration of microtube lasers on silicon
Kirk A.G. & 2 others (NSERC Strategic Research Program)
Participation of Reflex Photonics
$136,000

Graphene-Sn nanocomposites for Li-ion battery anodes
M. Cerruti (PI), T. Szkopek,
NSERC CRD
$ 36,927 from NSERC,
$19,130 from GM,
$25,910 in-kind from GM

Rapid detection of MRSA and identification of strain using an autonomous microfluidic chip with bacteriophages.
D. Juncker & 2 co-applicants
$ 172,200 (CHRP)

Scanning probe techniques applied to Nanoscience

P. Grutter (Discovery Grant)
$98,000

Quantum nano-sensors and quantum detectors
M. Hilke: (Discovery Grant)
$45,000

The direct growth of high-quality semiconductors
N. Quitoriano (Discovery Grant)
$29,000/year

New approaches to multiplexed protein profiling of complex samples with ultrahigh sensitivity
D. Juncker (Discovery Grant)
$ 45,000

Electron Beam Deposition System for Multi-User Nanofabrication Facility
A.G. Kirk (PI) and 13 others (RTI)
$148,200

Microsensors for physiological measurements in biomedical engineering
Elizabeth Jones & 4 co-applicants
$ 77,219 (RTI)

FQRNT:

Atomic force microscopy applied to low-temperature phenomena
Grutter & 3 others:
$58,000 + $50,000 equipment

Quantum Hall Information
G. Gervais & 2 others:
$48,000 + $50,000 equipment

Genetically Engineered Highly Selective and Sensitive Biosensors
V. P. Chodavarapu (PI) and 1 other,
$48,740

Hybrid Silicon Sensory Neural Electrodes: Simultaneous Recording of Oxygen and Electrical Activity from the Brain
S. Musallam (PI) and 2 others.
$56,000

FQRNT New Researcher
W. Reisner
$20,000 + $ 36,5000 equipment

Sélection artificielle à haut débit de l'expression génique chez les animaux utilisant une plate-forme microfluidique intégrée
Ehab Abouheif & 3 co-applicants
$ 66,000

Advanced Quantum Dot and Nanowire Heterostructures: Nanoscale-Patterned Growth
Richard Ares (PI), Z. Mi and D. Drouin
$50,000

Antimony-Based Long Wavelength Self-Organized Quantum Dot Lasers
Z. Mi (PI), V. Aimez, and P. Grutter
$61,000

NanoQuebec:

Integrated polymer electro-optic switches
Kirk, A.G. (PI) and Andrews, M
$20k industrial funding from DALSA semiconductor,
$ 66,667 NanoQuebec

CMOS Integrated Nitride Nanowire Array based Bacterial Biosensors
V. P. Chodavarapu (PI) and 3 others
$87,000

Other sources:

Nanoelectronics Experiments Using Coulomb Drag to Study Coupled One-Dimensional
G. Gervais:
USD$22,068 (Sandia National Laboratories, USA (Service contracts)

Quantum matter on-a-chip
G. Gervais:
$50k/3 (Tomlinson Science Prize)

Red Blood Cell Visualization and Analysis in Microflow
Marianne Fenech
$2,000 (CMC Financial Assistance)

Towards a Portable and Fully Automated SPR-Based Digital Microfluidics Array Platform Integrating Diffractive Optical Elements for Genomics and Proteomics
Maryam Tabrizian & 2 others
$133,333 (Genome Québec)

Nanoporous silicon catheter device with real-time optical monitoring of bacterial contaminants during hemodialysis
V.P. Chodavarapu (PI) and 1 other,
$31,900 (Canadian Institute for Photonic Innovations)

Bionanofluidics Laboratory
W. Reisner
$58,500 IOF (from a successful $ 732,500 total CFI Leaders Opportunity Fund)

Clinical validation of an innovative multiplex antibody microarray platform
David Juncker
$ 150,000 (CIHR , Proof-of-principle grant)

Antimony-Based Long Wavelength Self-Organized Quantum Dot Lasers Alternative Energy: Solar-to-Hydrogen
Z. Mi and H. Guo
$ 110,000 (Defense Research and Development Canada)