Building a PSM: Nanoscience at ASU

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Report to
CGS Workshop: Building and Gaining Recognition for PSM Programs
7 December 2011
Building a PSM: Nanoscience at ASU

- PSM choice, Science masters, WRGP
- Courses and Faculty
- Establishment of an Advisory Board
- Initial Marketing and Enrollment
- Development of a relevant Website
- The 4+1 model: BS-PSM
- Internships, Jobs, Employment
- Futures and Discussion

John Venables,
CGS Workshop,
Scottsdale, Dec 7, 2011
Skill set for PSM Students

• Ability to read and understand cutting edge science
• *Technical experience with the tools of modern science*
• Superior analytical skills
• *Ability to communicate well in writing & by spoken word*
• Ability to grasp and apply legal concepts, *wrt* patent law

*CNS, PSM Guide to establishing programs, 2011 p 17*

Initial timeline: PSM in Nanoscience

• Dec 06, early 2007: suggestion of MPhys in Nanoscience
• *Feb 07, JV chairs task-force, proposes PSM model*
• Authorization, Implementation proposals through 2007
• *Dec 07: First report to faculty (next two slides)*
What do we need to do collectively?

• Publicity, getting the word out: Contact colleagues, students, local/national industry

• *I will circulate you with a draft email and initial flyer. Please use widely, and copy me email addresses so that we do not duplicate*

• Talk to colleagues and contacts locally: Pub-power, University, City and State officials. Spread by word of mouth, use as ASU/ CLAS/ Physics & Chemistry booster
Some web addresses for publicity

• Flyer description at [http://physics.asu.edu/](http://physics.asu.edu/) More details forthcoming once we have ABOR approval (Jan 08). Leaflet to be prepared for wider circulation

• *The Professional Science Masters home page at [http://www.sciencemasters.com/](http://www.sciencemasters.com/)* We are applying to be added to this national list

• The Western Interstate Commission on Higher Education (WICHE) at [http://www.wiche.edu/](http://www.wiche.edu/) We are applying to be listed in the Western Region Graduate Program (WRGP) at [http://wrgp.wiche.edu](http://wrgp.wiche.edu)

• Finally, let me and the Chair know about anything that you know and we may not know...
## 12 month degree structure with 24 month P/T option

<table>
<thead>
<tr>
<th>Semester</th>
<th>Core + Elective Courses and Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Evening</td>
<td><strong>NAN 571: Quantum Physics (3 hours), as PHY 571 previously (summer semester not practical)</strong></td>
</tr>
<tr>
<td>(16 weeks)</td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td><strong>3 elective graduate courses (9 hours)</strong></td>
</tr>
<tr>
<td>(16 weeks)</td>
<td><strong>NAN 591 Professional Seminar (2 hours)</strong></td>
</tr>
<tr>
<td>Spring</td>
<td><strong>2 elective graduate courses (6 hours)</strong></td>
</tr>
<tr>
<td>(16 weeks)</td>
<td><strong>NAN 593 Applied Project (3 hours)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>NAN 591 Professional Seminar (0-2 hours)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>NAN 505 Science &amp; Society (2 hours, option)</strong></td>
</tr>
<tr>
<td>Final Summer</td>
<td><strong>NAN 506 Innovation &amp; IP (2 hours, option)</strong></td>
</tr>
<tr>
<td>(5 weeks)</td>
<td><strong>NAN 593 Applied Project (3 hours)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Capstone conference with project presentation</strong></td>
</tr>
</tbody>
</table>

Credit pattern \((3) + 11 + 11 + 5 = 30\) hours
## Core Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits, timing and description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAN 571</td>
<td>Quantum Physics</td>
<td>(3 hours, Fall Evening), as PHY 571 previously given in Spring <em>Venables, Matyushov</em></td>
</tr>
<tr>
<td>NAN 591</td>
<td>Professional Seminar</td>
<td>(2 hours, Fall and Spring), Interactive, using <em>visiting speakers</em>*, incorporating this <em>seminar series: Sankey, Venables + Mujica, Yu</em></td>
</tr>
<tr>
<td>NAN 593</td>
<td>Applied Project</td>
<td>(3 hours, Spring and final Summer) in wide range of nanoscience topics: from <em>Spring 2009, Faculty &amp; Projects on Nanoscience Web page</em></td>
</tr>
</tbody>
</table>

## PSM 'Plus' Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits, timing and description</th>
</tr>
</thead>
</table>
| NAN 505 & 506 | *PSM 'Plus' Courses           | (2 hours each, options) *Spring-Summer 2010*  
NAN 505: Nanoscience & Society *Ira Bennett*  
506: Innovation & IP... *Ken Polasko (AzTE), Menkus, Lefere (TVSG, School of Law)* |

**Fall 09, Spring, Fall '10, Spring 11: personal, Board involved**
PSM Applied Projects (2009-11)

- 12 student projects 2009-10, 8 Spring-Fall 2011, wide spread see [http://nanoscience.asu.edu/projects](http://nanoscience.asu.edu/projects)
- **Physics**: Bennett, Marzke, Nemanich (2+1), Smith/McCartney, Tsen, Chen
- **Biodesign Institute**: Lindsay, He, Meldrum, Hecht
- **Chemistry**: Gust(2), Levitus, Mujica, Ros, Seo, Williams
- **Engineering**: Goryll, Phelan (2), Tao, Yu
- **Other/off Campus**: Weissig, Polasko, Sukharev
- Currently fixing projects for Spring-Summer 12: students think/explore topic/advisors Fall 2011, 8 new projects needed, almost complete as of now
Program of Study: Elective courses

- Web listings at http://nanoscience.asu.edu/
- Three main broad options:
  - 1) Nanomaterials and Nanoelectronics
  - 2) Biophysics and Bio-Nanotechnology
  - 3) Biophysics, Biochemistry and Sensors
- Many Faculty involved in giving these courses to PhD, MS (Thesis) and PSM students across at least four Departmental Groupings: Physics (PHY), Chemistry & Biochemistry (CHM), Materials (MSE), Electrical & Electronic Engineering (EEE)
- Cross listing of Courses with Nanoscience (NAN) to give access to all such students and departments: Examples for Spring '11:
  - PHY/NAN 512/MSE 527: Materials Physics II  
    Fernando Ponce
  - NAN/PHY/CHM 544: Intro to Nanoscience  
    Stuart Lindsay
  - EEE/NAN 598: Molecular Electronics  
    Nongjian Tao
PSM Advisory Board at April 2011

Third Annual meeting: Seminar, Dr John Wager
Engineering, Oregon State University, Corvallis, OR

Solution-processed Inorganic Thin Films for Flexible and Printed Electronics

Hosted by Dr Stephen Goodnick (EECE)

External Board members (all PhD):

• Regan Stinnett (Sandia, Albuquerque), Board Chair
  • Travis Johnson (Agilent, Chandler)
  • Vladimir Noveski (Intel, Chandler)
  • Ken Polasko (AzTE, SkySong)
  • Nicholas Rizzo (Everspin, Tempe)
• Paul Weiss (Director CNSI, UCLA, Los Angeles)
ASU personnel in attendance

Collaboration: Physics, Chemistry and others

• Dr Robert Nemanich (Chair, Physics Dept)
• Dr William Petuskey (Chair, Chemistry & Biochemistry)
• Dr John Venables (Program Director, PSM in Nanoscience)
• Drs Vladimiro Mujica (Chemistry liaison, PSM Associate Director),
• Dr Hongbin Yu (Electrical & Electronic Engineering, EEE liaison)
• Dr Ralph Chamberlin (Physics, Graduate Chair)
• Dr Terry Alford (Materials Science & Engineering, Graduate Chair)

and also by invitation

• Dr Clark Miller (CNS-CSPO, Program Director PSM in Science Policy)
• Dr Patrick Phelan (EMTE, SoS, Program Director, PSM in Solar Energy)
• Dr Stephen Goodnick (EECE, Seminar Host) + Dr John Wager (Speaker)

Program Coordinator

• Ms Araceli Vizcarra (Graduate Coordinator, Physics & Nanoscience)
PSM Nano: current state of play

- May 2010: **16 students** on course: Andrew Walker graduated
- Summer-Fall 2010: **8 more students** graduated, total **9 alumni** and 1 Withdraw, 1 academic W; **5 students** still on course
- Fall 2010–Spring 2011: **6 more students** enrolled, i.e. **11** on course: provisions satisfied in one case, one other in progress
- Spring '11: **135 enquiries** (total to date); **38** since June 2010, of which 2 current students, **4 acceptances** for Fall 2011 so far
- Several more applications pending, including **3 likely** from ASU Physics Seniors and Juniors on Integrated BS-PSM. Note we are enrolling continuously; Can always use more publicity!
- **Broad subject base:** Current Alumni/ Students: 4 physics/materials, 6 chemistry/biochem, 2 nanotech MS, 8 EEE/IT
## PSM Nano: Admissions Statistics

<table>
<thead>
<tr>
<th>Date of Initial Inquiry</th>
<th>Initial Inquiries</th>
<th>Formal Applications</th>
<th>Went Dead</th>
<th>Formal Reject</th>
<th>Acceptances</th>
<th>Declines</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007 (Dec)</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2008 (June)</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2008 (Dec)</td>
<td>18</td>
<td>7</td>
<td>11</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2009 (June)</td>
<td>35</td>
<td>13</td>
<td>22</td>
<td>1</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>2009 (Dec)</td>
<td>18</td>
<td>2</td>
<td>16</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2010 (June)</td>
<td>22</td>
<td>11</td>
<td>11</td>
<td>2</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>2010 (Dec)</td>
<td>22</td>
<td>7</td>
<td>13</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Totals</td>
<td>119</td>
<td>43</td>
<td>74</td>
<td>7</td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td>2011 (June)</td>
<td>37</td>
<td>10</td>
<td>N/A</td>
<td>2</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>
Dec 2010: 119 inquiries ~1/3 apply, ~2/3 of these are accepted, ~1/6 rejected or decline, rest go dead (50%)

A new Web-site for publicity

➢ Publicity, publicity, publicity, we need publicity. So we decided (Drs Mujica, Nemanich: important contributions) on a new web-site at http://nanoscience.asu.edu/ for all our needs. Links and FAQ's for current students, Alumni, Courses, Faculty, Admissions, Seminars, Departments. Email: nanoscience@asu.edu for applications

➢ Please distribute Postcards, we have 1000 to find homes for…

➢ University presence is emerging at http://psm.asu.edu/ and an Arizona-wide PSM page at http://arizonapsm.wordpress.com/

➢ The PSM home page http://www.sciencemasters.com/ We are members of this national organization, also NPSMA http://www.npsma.org/ and the Western Region Graduate Program (WRGP/WICHE) at http://www.wiche.edu/wrgp
PSM program funding

• Arizona and National funding to explore: needs effort
• ASU liaison: Andrew Webber (Graduate College), Pat Phelan (Eng & SoS: Solar Engineering); Clark Miller, David Guston, Ira Bennett (CNS-CSPO, Science Policy)
• Stimulus package (ARRA): $15 Million NSF awarded; ASU’s Solar Engineering program is funded as is NAU’s Climate Change program: short duration and then what?
• AZ coordination of PSM programs, meeting Dec 2010 (Dr Mujica). Governor's P-20 Council, SFAz, AZ Tech Council
• Meanwhile back at the Ranch: Students pay full fees. Our PSM brought in ~$250k in Tuition 2009-10 : Where is it?
• Program Fees probably available 2011-12, will know soon; may get caught up in Tuition hike: ABOR this week
Please visit

http://nanoscience.asu.edu

- Links and FAQ's for Current students, Alumni, Course Offerings, Faculty-Staff, Future Students/Admissions, Seminars, Advisory Bd.

- Email: nanoscience@asu.edu for initial applications. Coordinator and/or Director respond directly to Inquiries using their own email.

- Interdisciplinary course, so the new website is NOT underneath a particular Department. Departments are referred to as Partnerships, under the home page tab. This widens the appeal (beyond Physics) especially as Physics is considered hard, and applicants have a range of Math, Physics and Chemistry background knowledge.

- University presence is emerging at http://psm.asu.edu/ and an Arizona-wide PSM page at http://arizonapsm.wordpress.com/
Recent and ongoing Issues

- **Online teaching**: two courses with online options offered in Fall 2010: MSE 518 (Tasooji) and MSE 550 (Alford). There is a demand to move more to Online, but...

- **Program Fees**: Proposal for $500/semester Full-time and $250/semester Part-time submitted August 2010. This is now agreed for new students from Spring 2012.

- **Integrated 4+1 BS Physics-PSM in Nanoscience** submitted fast track January 2011, and is already in place Fall 2011; we have 2 students on course in final (4th) Undergrad year.

- **Integrated 4+1 BS-PSM in Nanoscience with Materials (MSE), Chemistry (CHM) & Biochemistry (BCH)** in pipeline now, introduce in Spring 2012 for entry Fall 2012.
4+1 BSM-PSM details

• Integrated 4+1 BS Physics-PSM in Nanoscience in place Fall 2011; 2 students in final (4th) Undergrad year

• Choice of up to 3 courses (up to 9 credits) in common 4th and 5th years. Students save about 1 semester of FT work

• Courses specified at 500-level or joint 400/500 level PHY/NAN 544: Introduction to Nanoscience, PHY/NAN 511+512: Materials Physics I & II; flexibility in practice?

• Integrated 4+1 BS-PSM in Nanoscience with Materials (MSE), Chemistry (CHM) & Biochemistry (BCH) in pipeline now, introduce in Spring 2012 for entry Fall 2012

• Specifying Courses now: differences between Colleges inevitable, something has to give: Engineering, Liberal Arts
## Internships, jobs and OPT: state of play Fall 2010

<table>
<thead>
<tr>
<th>Student</th>
<th>Entry and FT/PT</th>
<th>Committee Members First destination job</th>
<th>NAN 505?</th>
<th>Graduation date/ NAN 506</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1, Az Resident Male</td>
<td>F 2008 PT</td>
<td>Venables (Chair) Matyushov, Oldjob on graduation</td>
<td>Spring 09</td>
<td>Spring 2010</td>
</tr>
<tr>
<td>#2, International Male</td>
<td>Transfer from Physics PhD FT</td>
<td>Smith (Chair, advisor) McCartney, Venables OPT on graduation</td>
<td>Spring 10</td>
<td>Summer 2010 NAN 506 (Electron Materials)</td>
</tr>
<tr>
<td>#3, Az Resident Female</td>
<td>F 2009 FT</td>
<td>Sankey (Chair), Goryll (advisor), R. Ros Newjob on graduation</td>
<td>Summer 2010</td>
<td>NAN 506 (Biosensors)</td>
</tr>
<tr>
<td>#4, Domestic, Wiche, Male</td>
<td>F 2009 FT</td>
<td>Seo (Chair, advisor) Kouvetakis, Matyushov PhD student at ASU</td>
<td>Summer 2010</td>
<td>NAN 506 (Materials Chemistry)</td>
</tr>
</tbody>
</table>

*Not all students will want internships:*
1) those with previous or current work experience
2) Full-time students who try to finish in one year
Internships, jobs continued at Fall 2010

<table>
<thead>
<tr>
<th>Student</th>
<th>Entry and FT/PT</th>
<th>Project Advisor First destination job</th>
<th>NAN 505?</th>
<th>Graduation date/ NAN 506</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5, Non-resident, Male</td>
<td>F 2009, FT</td>
<td>Marzke (advisor) Internship (AzTE)</td>
<td>Spring ‘10</td>
<td>Fall 2010; NAN 506 (AzTE, Physics)</td>
</tr>
<tr>
<td>#6, International, Female</td>
<td>F 2009, FT</td>
<td>Nemanich (advisor) Internship (Intel)</td>
<td>Spring ‘10</td>
<td>Fall 2010 No NAN 506</td>
</tr>
<tr>
<td>#7, International, Female</td>
<td>F 2009, FT</td>
<td>Bennett (advisor) US Job on graduation</td>
<td>Spring ‘10</td>
<td>Fall 2010; no NAN 506</td>
</tr>
<tr>
<td>#8, International, Male</td>
<td>F 2009, FT</td>
<td>Lindsay (advisor) US Job in 2011</td>
<td>Spring ‘10</td>
<td>Fall 2010; NAN 506 (Materials Physics)</td>
</tr>
<tr>
<td>#9, International, Female</td>
<td>F 2009, FT</td>
<td>He (advisor) Maternity plus move</td>
<td>Spring ‘10</td>
<td>Fall 2010; no NAN 506</td>
</tr>
</tbody>
</table>

Several students very much want internships:
1) Those in need of work experience, including OPT/ CPT
2) Full-time students who can prolong degree to 16 months
3) Students who need money: TA/ RA not generally given
# Internships, jobs at Fall 2011

<table>
<thead>
<tr>
<th>Student</th>
<th>Entry and PT/FT</th>
<th>Advisor First destination job</th>
<th>NAN 505?</th>
<th>Graduation date/ NAN 506?</th>
</tr>
</thead>
<tbody>
<tr>
<td>#10, Az-Resident, Male</td>
<td>S2010 FT</td>
<td>Gust (advisor) Job on graduation</td>
<td></td>
<td>Spring 2011 NAN 506</td>
</tr>
<tr>
<td>#11, Non-resident, Male</td>
<td>F 2010 FT</td>
<td>Polasko (advisor) Job on graduation</td>
<td>Spring ‘11</td>
<td>Summer 2011 NAN 506 (A)</td>
</tr>
<tr>
<td>#12, Domestic Wiche, Male</td>
<td>F 2010 FT</td>
<td>Phelan (advisor) Job on graduation</td>
<td>Spring ‘11</td>
<td>Summer 2011 NAN 506</td>
</tr>
<tr>
<td>#13, Az-Resident Male</td>
<td>F 2009 PT</td>
<td>Phelan (advisor) Oldjob on graduation</td>
<td></td>
<td>Summer 2011 NAN 506</td>
</tr>
<tr>
<td>#14, Az-Resident Male</td>
<td>F 2010 FT</td>
<td>Nemanich (advisor) Job obtained in 2011</td>
<td>Spring ‘11</td>
<td>Fall 2011; No NAN 506</td>
</tr>
<tr>
<td>#15, Az-Resident Male</td>
<td>F 2010 FT</td>
<td>Gust (advisor) Job on graduation</td>
<td>Spring ‘11</td>
<td>Fall 2011; no NAN 506</td>
</tr>
</tbody>
</table>

*All students want Jobs!*

1) All six 2011 graduates have jobs; 2) None did Internships…
Employment opportunities for future PSM program graduates in Arizona
Employment opportunities

1) Arizona Silicon Desert map from
http://www.siliconmaps.com/silicon_desert.html
But questions: 
  a) does it just cover large industries?
  b) are we looking more to SME’s and Startups?

2) Good synergy with Industrial Affiliates Program
Win-win strategy is possible, but requires time from someone

3) How best to approach Local Industries
Can it really be done at department/ program level?
How does one cope with rapid change of industry personnel?
Role of the Advisory Board: they are all working pro-bono...
Strategy for on-line teaching and/or use of other programs’ on-line courses

• Opinion is divided on Online courses, but (at least for a proportion) that's the way its going...
• Many NAN courses have an Online component already: Blackboard shells, Online discussion groups, Digital drop boxes, Email to groups, etc
• NAN 505: Nanoscience & Society Ira Bennett Discussion topics, Off campus tele-presence teaching
• NAN 544: Introduction to Nanoscience Lindsay Book now published, Large enrollment, Use of YouTube
• NAN 571: Quantum Physics Matyushov Online assignments with Mathematica, Digital submission
• NAN 591: Professional Seminar Mujica, Venables, Yu Discussion groups, Projects, Reprint sharing, Networking
Strategy for on-line teaching and/or use of other programs’ on-line courses

• Part-time students in particular welcome Online, as a perceived way to get through more material or courses; Some out-of-state students would join if *all Online*

• Probably a way to cope with larger classes: student interaction encouraged, but of course there are pitfalls

• Other professions/ schools are way ahead of us: e.g. Nursing, Social Work, Engineering (*Online MSE*)
   Opportunity for sharing Online provision if subject material is compatible

• Current aim to get some of the most popular courses Online, but all Online is not an immediate aim.
Conclusions and Futures

• Early Days, but PSM (locally and nationally) is at an exciting stage. At ASU and in Arizona programs are at various stages of development and external recognition

• *PSM in Nanoscience is currently our Flagship program (I am very proud to have developed it to this stage…)*

• Government funding is important (e.g. NSF stimulus to ASU and NAU), but not the only way

• *Build it, they will come? Is this sufficient?*

• *Word of mouth publicity is the best, but there are a lot of potential students to reach out there: Partnerships/Wiche*

• Social Media: Facebook, Twitter, no, but maybe LinkedIn; Early stage of discussion, not everyone wants in, but we are consulting students/alums