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March 30, 2012    Bangkok   Thailand
Non-profit vs for profit motivation for R&D

- Key objectives differ: production of researcher vs production of commercially viable research

- Different time scales – too long in academia; potential opportunity cost for industry

- IP issues - major deterrent in biotech, medical, computing, software areas in particular where patents are important
Cost of academic R&D not always lower than industrial; cost may not be factor

Universities may have specialized equipment and talent that is sought by industry

Knowledge generation vs knowledge utilization- hard to balance
Some suggestions to enhance A-I cooperation

- Identify and publicize to industry special expertise academia/academics have
- Define R&D project scope, schedule and funding model as well as IP policies
- IP policies depend on companies and academia- no magic bullet or one-size fits all formula- global problem!
- Publication may be restricted so unwise to employ PhD students on such projects
More on A-I cooperation

- Define project scope/objectives that are mutually agreeable
- R&D involves RISK-key element of any true research-industry must understand this or may cause problems later
- Funding should be for full project duration and must include indirect costs-partial funding is a BAD idea
- Avoid totally new area unless full and sustainable R&D funding is assured
Some observations on A-I collaboration

- There are significant global variations e.g. A-I is very high at NTNU in Norway in energy, civil engineering, oil/gas but not in mining industries. Depends on location, local culture, government policies and degree of conservatism of industry.
- If large corporations have R&D Centres in home countries, hard to do A-I with such companies. Reverse innovation possible but hard.
Best candidate companies for A-I

- Those with significant home based R&D
- Those which are not very large (who do not have their own R&D Centre)
- Those which are very small—cannot afford R&D unless Govt. funds it fully
- Medium size firms are best to approach
- Academics must have recognized expertise and lab facilities which industry cannot readily duplicate
- Companies not accepting of Open Innovation unlikely to collaborate
Appropriate A-I Projects

- Should not be very long term as industry is always in a hurry for results; may drop some R&D in mid-stream as well
- Very short term projects best handled as consulting projects
- Provide seminars, workshops to local industry to develop close interaction; informal start-ups are normal
- Faculty needs awareness of industry needs and profit motive; sabbatical periods in R&D centres can help
- Invite industry to give Guest Lectures
Excellence breeds excellence; no weak link should exist in calibre of students, faculty, facilities and administrative teams

Excellence breeds excellence; first class people hire first class colleagues while second class people hire third class colleagues (per Parkinson’s observation, 1956)

Must have good mentoring and role models for junior faculty; no short cut to experience
Fresh Lecturers/ Assistant Professors need to be advised of key performance indicators that will be used in their Promotion/Tenure exercise—vary widely!

Teaching/Research/Service are weighted differently in different institutions—best to start with all three from get go!

Student feedback and Peer assessment are helpful; plus numerous resources are readily available to enhance teaching

Subscribe to Stanford Newsletter “Tomorrow’s Professor”—valuable resource
Teaching - some thoughts

- Use IT to advantage but not to limit learning ability of students; Power Points can give false impression to students that viewing them results in learning! Encourage self-study!
- Lecture Notes-based teaching/learning in preference to high quality textbooks is a serious impediment to learning - try to correct it (if you can!)
- Education/learning is NOT entertainment although a strong correlation can be observed between student scores and words like interesting, enjoyable, funny, humorous etc in student feedback
On learning

- Teaching/learning are flip sides of same coin—remember same teaching yields both A+’s and F’s
- Teacher should **facilitate learning**
- Make it simple but not simpler (Einstein)
- Self study is a must as students now must engage in **lifelong learning**
- Peer learning, working in teams, oral/written communication skills, ability to work in multi-cultural, multi-disciplinary teams is a necessity; breeds innovation and creativity as well
Be innovative- not a good idea simply to extend PhD project- shows lack of originality
Most research areas have finite half life- it is necessary to be prepared for initiating cutting-edge research in new areas- **improve your fundamentals** which can allow switches often dictated by funding agencies
Prepare proposals for funding carefully (a major topic to lecture on!)-success rates are getting progressively lower everywhere! Form strong, coherent teams **required by project needs**.
Avoid “me-too” research; maybe forced into Buzz-word research due to availability of funds- but try to extend it into your own ASAP
Do not undertake something simply because it has not been done before- may there is good reason why no one did it!
Do not venture into areas with no expertise; first develop it and then jump into it
Opportunity knocks a the door of the “prepared”!
Collaborate locally/internationally where possible. Limited R&D resources will require networked approach in future.
More about Research

- Engineering research should have medium to long term application potential
- Best to have a portfolio of short/medium/long term projects
- Avoid closed loop approach; Research by academics and for academics is a poor model. There should be an eventual application if research is successful
- Try to include element of innovation in every project - should not be a logical extension of what you or others have done.
On mentoring

- If no senior role models are available locally in your area(s), seek **virtual mentors**—they may be anywhere on the globe!
- Use internet to network and find good mentors—maybe multiple mentors if necessary!
- Virtual mentors can be just as effective; study their professional career and seek advice now and then. Most will be happy to help/guide. Co-advisors can be sought from successful institutions
- Spend sabbatic time elsewhere
Success in research

- Publication/conference presentation are modes of knowledge dissemination required in research-intensive universities.
- Publish or Perish has been the mantra for decades - change it to Publish and Flourish!
- Publish only what is worth archiving; avoid bean counting citations, impact factor etc.
- Focus on ranking by nonacademic profit-making institutions is distorting evaluation process for grants/research outcome etc.
Publishing

- Improve writing/oral delivery skills- very critical in building up professional recognition. *Practice makes perfect!*
- Provide efficient and effective service to your department/faculty/university as well as national professional bodies international professional societies- develop global network
- Advise graduate students carefully but avoid doing thinking for them; let them learn by doing- no short-cuts!
Ethics, Ecology, Economics - 3E's

- Always be ethical in teaching, research and service - major concern everywhere!
- In engineering stress the need to reduce environmental impact, reduce carbon footprint and cost of any product or process you design or teach how to design
- Pay attention to Life Cycle Assessment of all products and processes
Closing comments

- Touched on very few key points for lack of time
- Visit [http://serve.me.nus.edu.sg/arun](http://serve.me.nus.edu.sg/arun) for selected write-ups and PPTs which are relevant to theme of the Panel discussion
- Important point: Think Global but Act Local
- Make innovation a key element of teaching/Research and service.
Study Intellectual habits of Critical Thinkers; stay abreast of published work in your own area and in peripheral areas to stimulate creative/critical thinking and innovation.

Book by Paul and Elder (2001) on Critical Thinking has useful pointers—Seven habits of Critical Thinkers—see next slide.
Seven habits of Critical Thinkers

- Intellectual humility
- Intellectual courage
- Intellectual empathy
- Intellectual integrity
- Intellectual perseverance
- Confidence in reason
- Intellectual autonomy

All of above should be carried out proactively with due regard to ethics, ecology, energy and economy.
THANK YOU FOR YOUR ATTENTION

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