1st Series Lectures: World University Ranking: Caltech Model for University & Industry Working together

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- Rockwell International.
- Monsanto.

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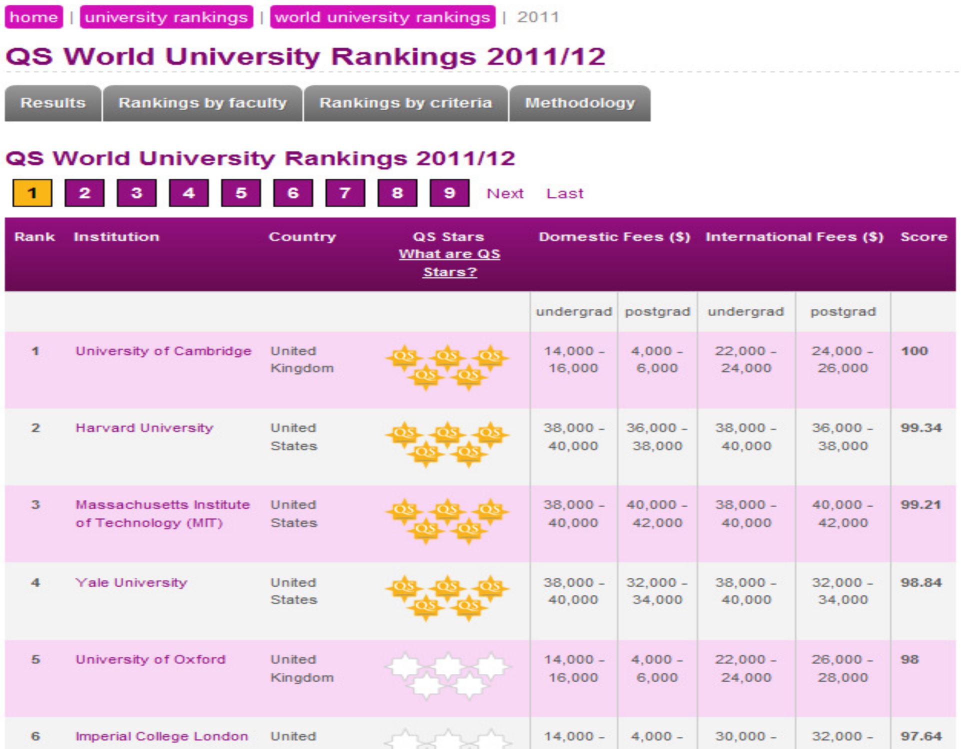

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QS World University Rankings 2011/12

Results | Rankings by faculty | Rankings by criteria | Methodology

QS World University Rankings 2011/12

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Rank	Institution	Country	QS Stars What are QS Stars?	Domestic Fees ($)		International Fees ($)		Score
				undergrad	postgrad	undergrad	postgrad	
1	University of Cambridge	United Kingdom		14,000 - 16,000	4,000 - 6,000	22,000 - 24,000	24,000 - 26,000	100
2	Harvard University	United States		38,000 - 40,000	36,000 - 38,000	38,000 - 40,000	36,000 - 38,000	99.34
3	Massachusetts Institute of Technology (MIT)	United States		38,000 - 40,000	40,000 - 42,000	38,000 - 40,000	40,000 - 42,000	99.21
4	Yale University	United States		38,000 - 40,000	32,000 - 34,000	38,000 - 40,000	32,000 - 34,000	98.84
5	University of Oxford	United Kingdom		14,000 - 16,000	4,000 - 6,000	22,000 - 24,000	26,000 - 28,000	98
6	Imperial College London	United		14,000 -	4,000 -	30,000 -	32,000 -	97.64

Academic Ranking of World Universities

ACADEMIC RANKING OF WORLD UNIVERSITIES SINCE 2003

Home | About | Rankings | Universities | Initiative | Conferences | Reso

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Academic Ranking of World Universities - 2011

World Rank	Institution	Country	National Rank	Total Score	Score on Alumni
1	Harvard University		1	100.0	100.0
2	Stanford University		2	72.6	41.2
3	Massachusetts Institute of Technology (MIT)		3	72.0	72.8
4	University of California, Berkeley		4	71.9	68.3
5	University of Cambridge		1	70.0	87.1
6	California Institute of Technology		5	64.7	52.6
7	Princeton University		6	61.2	56.7

3 Most influential International University Rankings:

1) QS World University Rankings.

2) THE World University Rankings.

3) Academic Ranking of World Universities (Shanghai Ranking)

THE WORLD UNIVERSITY RANKINGS 2011-12

Times Higher Education

POWERED BY THOMSON REUTERS

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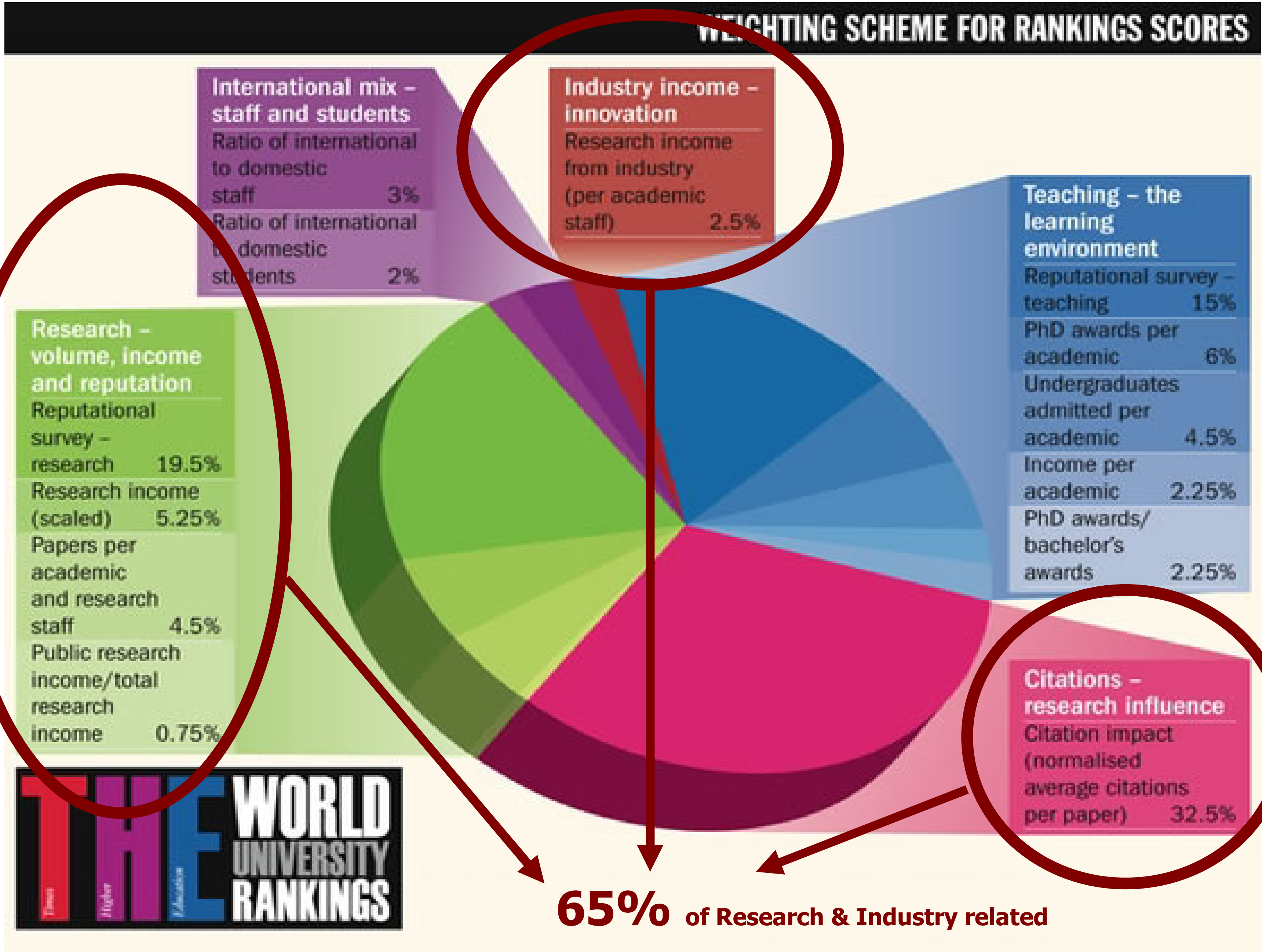
RANKINGS HOME | RANKINGS BY YEAR | BY REGION | BY SUBJECT | ANALYSIS | REPUTATION

THE WORLD UNIVERSITY RANKINGS 2011-2012

001 - 200 | 201 - 225 | 226 - 250 | 251 - 275 | 276 - 300 | 301 - 350 | 351 - 400

WORLD RANK	INSTITUTION	COUNTRY / REGION	OVERALL SCORE change criteria
1	California Institute of Technology	United States	94.8
2	Harvard University	United States	93.9
2	Stanford University	United States	93.9
4	University of Oxford	United Kingdom	93.6
5	Princeton University	United States	92.9
6	University of Cambridge	United Kingdom	92.4
7	Massachusetts Institute of Technology	United States	92.3
8	Imperial College London	United Kingdom	90.7
9	University of Chicago	United States	90.2

Introduction: THE World University Rankings 2011



Industry income — innovation

- This category is designed to cover an institution's **knowledge-transfer activity.** It is determined by just a single indicator: a simple figure giving an institution's research income from industry scaled against the number of academic staff.
- Plan to supplement this category with additional indicators in the coming years, but at the moment it is the best available proxy for high-quality knowledge transfer. It suggests the extent to which users are prepared to pay for research and **a university's ability to attract funding in the commercial marketplace** — which are significant indicators of quality.
- However, because the figures provided by institutions for this indicator were patchy thus, THE has given the category a relatively low weighting for the 2010-11 tables: it is worth just 2.5 per cent of the overall ranking score.
- This will be a significant factor in coming years.

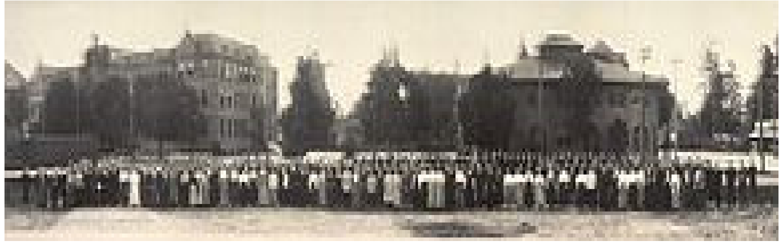
Citations — research influence

- A university's research influence — as measured by the **number of times its published work is cited by academics** — is the largest of the broad rankings categories, worth just under a third of the overall score.
- This weighting reflects the relatively high level of confidence the global academic community has in the indicator as a **proxy for research quality**.
- Clear evidence of a strong **correlation between citation counts and research performance**.

Research — volume, income and reputation

- Academics are likely to be more knowledgeable about the reputation of research departments in their specialist fields.
- A **university's research income, scaled against staff numbers and normalised for purchasing-power parity**. Also, influenced by **national policy and economic** circumstances. **Research income is crucial to the development of world-class research,** and because much of it is subject to **competition and judged by peer review**.
- The research environment category also includes a simple measure of research volume scaled against staff numbers. We count the number of papers published in the academic journals indexed by **Thomson Reuters** per staff member, giving an idea of an **institution's ability to get papers published in quality peer-reviewed journals**.
- **Measurement of public research income against an institution's total research income.** This has a low weighting to reflect concerns about the comparability of self-reported data between countries.

A Brief History of Caltech



Began as a vocational school in 1891. Later renamed Throop Polytechnic Institute in 1908 at downtown Pasadena, Calif. In 1920, it was named Caltech.

In 2010, Endowment= US 1.55b; 294 Professional faculty; 1207 other faculty, 2231 students (978 UG & 1253 PG).

The Sloan Laboratory for Mathematics and Physics

The Annenberg Center for Information Science and Technology

The Millikan Library, the tallest building on campus

The Bridge Laboratory of Physics

The Kerckhoff Laboratory of the Biological Sciences

Schlinger Chemical Engineering

Cahill Center for Astronomy & Astrophysics

NASA Jet Propulsion Lab (>5000 employees + industry)

As of 2010:

- 31 Nobel Laureates with 32 awards.

-56 Awarded US National Medal of Science.

-10 Awarded National Medal of Technology.

- 1 Field Medal.

- Visiting professors: James Watson (Cambridge), Albert Einstein, Stephen Hawkings (Cambridge)

Case studies: University & Industry In Collaboration at Caltech

Industry's Perspective: Motorola

The First Cellphone (1973)

Name: Motorola Dyna-Tac
Size: 9 x 5 x 1.75 inches
Weight: 2.5 pounds
Display: None
Number of Circuit Boards: 30
Talk time: 35 minutes
Recharge Time: 10 hours
Features: Talk, listen, dial

Dr Martin Cooper- formerly VP & Director of Research, Motorola. The inventor of the first portable handset and the first person to make a call on a portable cell phone in April 1973. The first call he made was to his rival, Joel Engel, Bell Labs head of research.

Real-life experience: Motorola & Caltech Working Together

- External factor: Threat of severe cutbacks in Government-funded university research.
- Inherent mutual challenges:
  - **survival** of corporations: contingent on an increasing flow of **quality** graduates educated in fundamentals of S & T from universities which have reasonable facilities in using modern problem-solving tools.
  - Primary product of Universities: Graduates; Market: university, government & industry.
  - In US, Industry is the source of goods & services of material substance to US society.
  - Reluctant bedfellows: How to bring University & Industry together?

Universities' interests:

- To educate.
- Do research- to keep the faculty interested & in Caltech, research is a very important part of the educational process.
- Seen by industry as the source of educated engineers & scientists & inspiration! Also, some sense of **direction for Industry long-range** technology expenditures. University environment enables more time thinking about what is going to happen in 10 or 15 years than corporate people bogged down in meeting yearly P&L req.

Motorola's experience:

- Funding to Universities which will encourage continuing dialogues between the academics & our people i.e. Caltech. Funding from Motorola Foundation- purely charitable.
- Silicon Structures Project: Hire prospect researchers away on sabbatical basis.
- **Short-sighted approach**: offer salaries in excess of what Caltech can offer & if an individual not a dedicated educator, he/she will work in industry. Create tense situation with university management.
- **Corrective approach** now: Encourage financing of students who will remain in university & teaching roles. But this does not solve the problem.

Motorola's experience:

- Initial issues: **not productive** relationships from both sides; instead each side focuses on their current work.
- **Individual Interaction** with academia staff due to specific industry areas of interest: Bear fruits. Based on own volition, get together & establish successful relationships.
- Ignorance of Motorola: Assume academia is going to manage, produce what they need & all problems will be resolved!
- University comes to rescue by carry out 1st stage of research for Motorola when Motorola wanted to establish a worth enough inventions to invest (not core interest).
- Involved in Caltech **related R & D program** such as power electronics program at Caltech (even though not of Motorola's core biz)
- **Silicon Structures Project**: Joint research in Very Large Scale Integration with short term benefits and long term problems (with inspiration!). Unique element: having industrial participants live full time at Caltech for 1 year. When back to industry, the concepts, philosophy & understanding of what is happening at Caltech will be shared among other colleagues.

Observations:

1. Technologists in Industry as **advisors** in university funding programs. Chief value: Open channels of communication- when there is an industry-related problem, the advisors can communicate with someone he/she knows & trusts. Being able to call that person has **direct value**.
2. Industry technologists should have **frequent visits** to Caltech. Mechanisms: hold seminars on university property & networking among peers.
3. Industry should **not expect much in short term results** & gain from investing in university collaboration. It is a long term investment.

Observations:

4. University collaborative programs that address the issue of **productivity** should be increasingly attractive to industry as productivity is the biggest challenge in US society.
5. **Publication & proprietary rights**: **Progressive** universities allow investing industry to maintain some kind of **rights** in the results of research. Some universities require all research be fully published-great inhibitor for industry. Industry **reluctant** to invest research that likely benefit their competitors.

Observations:

6. Universities restrain their tendency to overpromise, appealing to long-range views to industry rather than promising short-term results.
7. Industry & Universities must attack these issues & it is in the **best interests** of all to learn to work together on **solutions**.

Industry's Perspective: Monsanto

- Issues: Internal problems universities must wrestle when collaborate with industry; price industry must pay to consider academic collaboration. **ROI** is expected from university funding.
- Monsanto's soul searching process of finding a suitable academia collaboration includes patent issue, senior management commitment & R & D staff involved.
- **Patent**- industry concerns with secrecy issue, pivotal whether collaboration can work. For university, secrecy issue is threatening their need to publish, attending meetings & talk about their work. Invention is the least expensive part of the innovative process i.e. for every dollar spent to invent something, many hundreds more required before that invention reaches the **market place**.
- Big **economic risk** is not in supporting research but when **building manufacturing plants to produce new materials**. Without adequate **patent protection** (with academia's assurance), no company can afford to invest the large amounts of money required to bring a new product to commercialization.

MONSANTO

MONSANTO
imagine

Issues:

- Senior management commitment: Will the potential rewards from the agreement be **commensurate** with the investment that is required? **Justifications** required for the company Board's decision.
- Internal R & D staff: Industrial scientists work for a salary & their inventiveness is rewarded with promotion, higher salary & prize. Yet, great invention is not making a company scientist rich! In academic, individual scientists earn royalties on their invention. Thus, collaboration produces **significant different rewards** for various scientists involved could lead to **major morale problems** within company.
- Industry thinks that existence of an outside research project has the potential **causing internal problems**.

Motivation Pursuing Collaboration:

1. Caltech possesses **valuable skills** which industry cannot wait for another 10 years or more to develop internally.
2. Monsanto's experience in small collaborative programs teaches her to deal with academia collaboration. **Lessons learnt**: Must have partners whom can be **trusted & worked together**. Not someone hired to do jobs.

Our Approach:

1. Deal with an **issue of great sensitivity on both sides**- the tradeoff between security for patent purposes and academician's right to publish. Here, Monsanto has the right to **a 30-day** look at papers prior to their being submitted for publications; if patentable material is included, a chance to put off submission for a short period longer to provide time to file the proper patent applications. Both sides agree on this arrangement & any contract include some mechanism for dealing with a proprietary situation.

MONSANTO
imagine

2. Arrangement should be between **institutions** rather than individuals. This prevents the kind of distortion that happens when one individual receives large sums of money that are not available to his colleagues. If major royalties should accrue to the university as a result of the work, 1/3 of them will go to the university, 1/3 to individual scientist's dept & 1/3 to his lab (but not to any individual investigator). A **win-win** situation to both sides where faculty members remain **on par** whether working on Monsanto-funded programs or others. Academic scientists remain on an equal level with collaborating Monsanto scientists; thus **avoid morale issue** of any particular group of collaborating scientists becoming rich while others not.

3. Collaboration should be a **real partnership**, a relationship of **equals**. Industry must has **in-house** skills in the particular area of the agreement. Further insured the partnership by forming an oversight committee (4 from each sides) to administer funds for the individual research projects. University decides what research to engage while Monsanto selects from the projects of interest. So, it is more of which aspects of university proposed projects are **worthwhile** to Monsanto.
4. **Scientific peer review**: Assessed by objective, informed outsiders at regular intervals- assured of proper quality & progressing apace. Outside panel insures research carried out as original intended. Academic-industrial collaboration is **not** meant for **development** programs for new products as development is the role of industry else a gross mismanagement of funds, time & government resource.

5. Collaborative driving force for Monsanto is the **biological revolution**, accompany by exciting advances in Chemistry & Physical measurement. Monsanto needs **retooling** by piggyback on Caltech skills as it builds up its own skills & heighten ability to bring **new products to market**. Thus, the outcomes are **beneficial to both sides & society.**

MONSANTO imagine

In Summary:

- A successful academic-industrial collaboration brings **new products** to consumers and enhance industry technological capability through universities' enormous scientific skills. This will ensure **industry** more **competitive internationally**. Under the right circumstances, university & industry are natural partners and such partnerships hold great promise.

Industry's Perspective: Rockwell International

Funding to university: 1. Rockwell Charitable Trust (Grants, gifts, scholarships, fellowships, chairs, building, matching funds, equipment).

2. Rockwell normal biz expense (contract money, overhead & internal R & D project).

- Rockwell Trust Criteria: Goodwill, minority responsibilities, community contribution, acquiring employees, patron of S & E, self-interest in particular technology in university.
- At Caltech, major grant involved due to direct technical interest & patron of S & E particularly in study of turbulence & semiconductors.
- **6 Steps:**

1. Prelude: Years of industrial association with Caltech without much investment involved.

Rockwell International

Robert Anderson, CEO of Rockwell International, prime contractor for the Space Shuttle working with the designer of Rockwell's 1st building, testing, first launch and touchdown of its first space shuttle.

Robert Anderson, CEO of Rockwell International (far left) at the "First Launch of the Space Shuttle Columbia," commissioned by Rockwell International, prime contractor of the Shuttle.

2. **Stimulus** triggered by Robert Anderson (Chairman/CEO Rockwell International & Member of Caltech Board of Trustees): Robert instructed the creation of a research grant at Caltech. It took 4 months for the Rockwell's executives to assemble & gathered formally at Caltech (in btw a meeting was cancelled 6 times!). When the meeting happened, it was a magnificent meeting. This key meeting is the beginning of the collaboration.

3. A series of **"How abouts"** where conducted among Rockwell's VPs for suggestions of 12 topics of technology strategic to Rockwell. This was proposed over to Caltech for consideration. Within 2 weeks, Caltech came back with a package of "How abouts" with 7 matches. Rockwell finalized 2 i.e. Turbulence & Semiconductor projects.

4. **Soft discussion** ensued with Caltech when the Trust money approved for the projects. Since it is a **charitable** money, Rockwell did not enter into "hard" negotiations with Caltech. But some gentlemen's understanding were agreed with Caltech. Soft discussion: working with Caltech's public relations office on simple agreement between Caltech's Provost & Rockwell, research fields & principal investigators captured in 1 page paper submitted by each faculty member. It covers starting period, contribution times, publicity (no one would rush to press without telling the others), published reports and other communications (Rockwell would get the 1st copy of any published report and a letter yearly for update), access and visitation.

5. **Financial auditing**: Access to records, cost reporting procedures, SOPs used by Caltech before.

6. Appointment of 4 Rockwell scientists in each projects as **liaison scientist**. All these 6 steps took 9 months to put together.

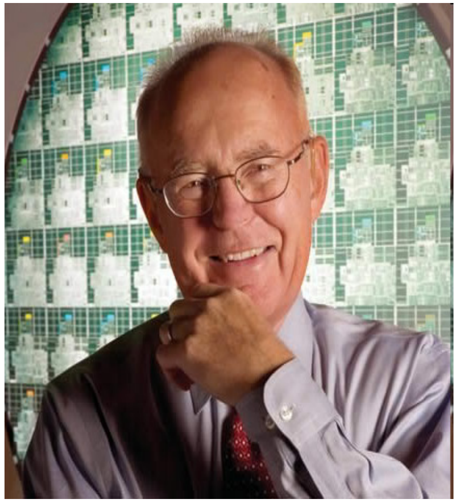
Caltech

"The Truth Shall Make You Free"

Caltech's Perspective:

8th President of Caltech: Dr Jean-Lou Chameau

NASA's Jet Propulsion Lab Director: Dr Charles Elachi



Dr Gordon Moore, Life Member & Chairman Emeritus, Caltech Board of Trustees.

Intel Corporation, Founder & Chairman Emeritus.

"Do not go where the path may lead; Go instead where there is no path, and leave a trail"- Ralph Waldo Emerson.

Challenges from Academic's Perspective:

1. Should any group have preferred access to students and postdoctoral fellows with respect to consideration for employment?
2. How should we handle patent rights?
3. How should we handle proprietary information? In the purest sense, such information has no place on university campuses, but, pragmatically, it is often generated in applied research in commercially competitive areas.
4. What restrictions, if any, should there be on the publication of results?

5. How can we in the universities preserve necessary balance in our programs? Industry has rather suddenly discovered that there are rapidly developing **new** areas such as biotechnology, integrated optics and computer science, in which industry is far from up to speed. Because they wish to **establish** positions in these areas as rapidly as possible, many corporations are very willing to pump money into university research and have their personnel participate directly in it. But it is important for each university to preserve **balance** in its programs (and especially set aside resources to nurture those areas where the next potential breakout may only be a gleam in a young professor's eye). One way to help achieve and maintain balance would be to have each **restricted-purpose gift accompanied by an unrestricted grant** to use at the university's discretion.

Under Old System….

- No money changed hands…University & Industry each benefits with mutual saving of time and money…
- Possible as University research was financed primarily by the Government in part through corporate taxes.
- But nobody likes taxes. Thus, taxes have been reduced & government spending for research also been reduced.

Consequently….

- To maintain the level of basic research the country needs to keep the economy vital in the long run, new sources of money required i.e. from industry.
- Universities are knocking at industry's door. Some less-favoured universities in such straits & in fact willing to act as low-cost research institutes for specific industrial projects. Undesirable & not good use of universities.

A better Approach…

- Illusory objectives in supporting university research i.e. for industry to benefit by **inspiration & ideas** as well as by **fostering education** of students in important fields but to have **no more than the illusion of directly benefiting by gaining exclusive patent rights** to breakthrough **inventions**.

What about publication problem?

- Based on “Scientific Communication & National Security Report” by US National Academies of Sciences, Engineering & Medicine, a simultaneous submission to Journals and the sponsors should suffice for national security purposes.
- Some industry reps on the panel supported this view.
- Industry generally would like to have access to Dept of Defence-sponsored research promptly but argue for **substantial delays** in publication for industry-sponsored research where **patent rights** might be involved. The difference of viewpoint is of contention here.

What should industry-university partnerships be like?

- A very **open one** with all of the companies interested in Caltech’s work. Nevertheless, Caltech understands many corporations giving money for specific purposes with natural proprietary feelings about open dissemination of results to those who did not support the work.
- Caltech’s concern- too **tight** partnerships could well lead to perceptions that ideas, research programs and students can be **bought** and sold on university campuses.
- Industry channels money to Caltech through **Industrial Associates program** or some without strings attached.

Challenges of Collaborative Work:

- If collaborative projects involving restricted access or patent rights from other companies in which donor companies also interested, we may **inhibit** their right of access to ideas, results and students. Thus, creating **internal conflict of interest.**
- Caltech takes great care in making *relationships* not to foster undue channelling of research & not to **prejudice** the collegial environment which itself actually defines Caltech's success.

Our Approach:

- Corporate support channels through Industrial Associates Program: **Membership subscriptions** by companies in return for the opportunity to keep up to date on Caltech's research programs & participate in important conferences on scientific and engineering subjects (similar approach done at University of Cambridge through Cambridge Network).
- Industrial Associate Program Team: Consists of intellectually curious individuals who actively promote Caltech's Industrial mission and support the transformational scientific discoveries of tomorrow.
  - Cultivate the membership of the Associates for increased support of the Institute through direct membership solicitation and programs.

- Lead an impactful program that includes ~**20** annual engagement events, regional events, targeted personal interaction opportunities, and travel programs all designed in coordination with industrial funding efforts.

- All corporations in the memberships are partners. Caltech could fulfil their educational mission through **dissemination** of their results in conferences and by individual visits, with neither side holding back.
- Office of Technology Transfer: Promote & facilitate the transfer of useful technologies to the commercial sector so that the public can directly benefit from the ingenuity and creativity of Caltech’s work. Assists the faculty with intellectual property, evaluates inventions, manages the Caltech/JPL patent portfolio, negotiates technology licenses and assists entrepreneurs with the creation of startups. **Annually:** 150-200 invention disclosures, 120-140 patents awarded, licensed 40-50 inventions, establish 8-12 start-up firms.

- The **Rockwell** arrangement was fun to negotiate, and you will note that it calls for no patent rights and no restrictions on publication. It does foster our strength in areas in which Rockwell has a deep interest. This is another very **useful model** *for collaborative* research *with industry,* and *it* has many advantages.
- One possible problem is that of creating some unbalance in our programs, a difficulty which might become serious if **several other companies** decide they want to **push the same research areas** here.

Types of University-Industry Relationships at Caltech

Corporate contributions to university

Undirected corporate gifts to university fund

Capital contributions: gifts to specific departments, centers, or laboratories for construction, renovation, equipment

Industrial fellowships: contributions to specific departments, centers, laboratories as fellowships for graduate students

Procurement of services

By university from industry: prototype development, fabrication, testing; on-the-job training and experience for students; thesis topics and advisers; specialized training

By industry from university: education and training of employees (degree programs, specialized training, continuing education); contract research and testing; consulting services on specific, technical, management problems

Industrial associates: single university; usually multiple companies; industry pays fee to university to have access to total resources of university

Cooperative research

Cooperative research projects: direct cooperation between university and industry scientists on project of mutual interest; usually basic, nonproprietary research. No money changes hands; each sector pays salaries of own scientists. May involve temporary transfers of personnel for conduct of research

Cooperative research programs: industry support of portion of university research project (balance paid by university, private foundation, government); results of special interest to company; variable amount of actual interaction

Research consortia: single university, multiple companies; basic and applied research on generic problem of special interest to entire industry; industry receives special reports, briefings, and access to facilities, for example

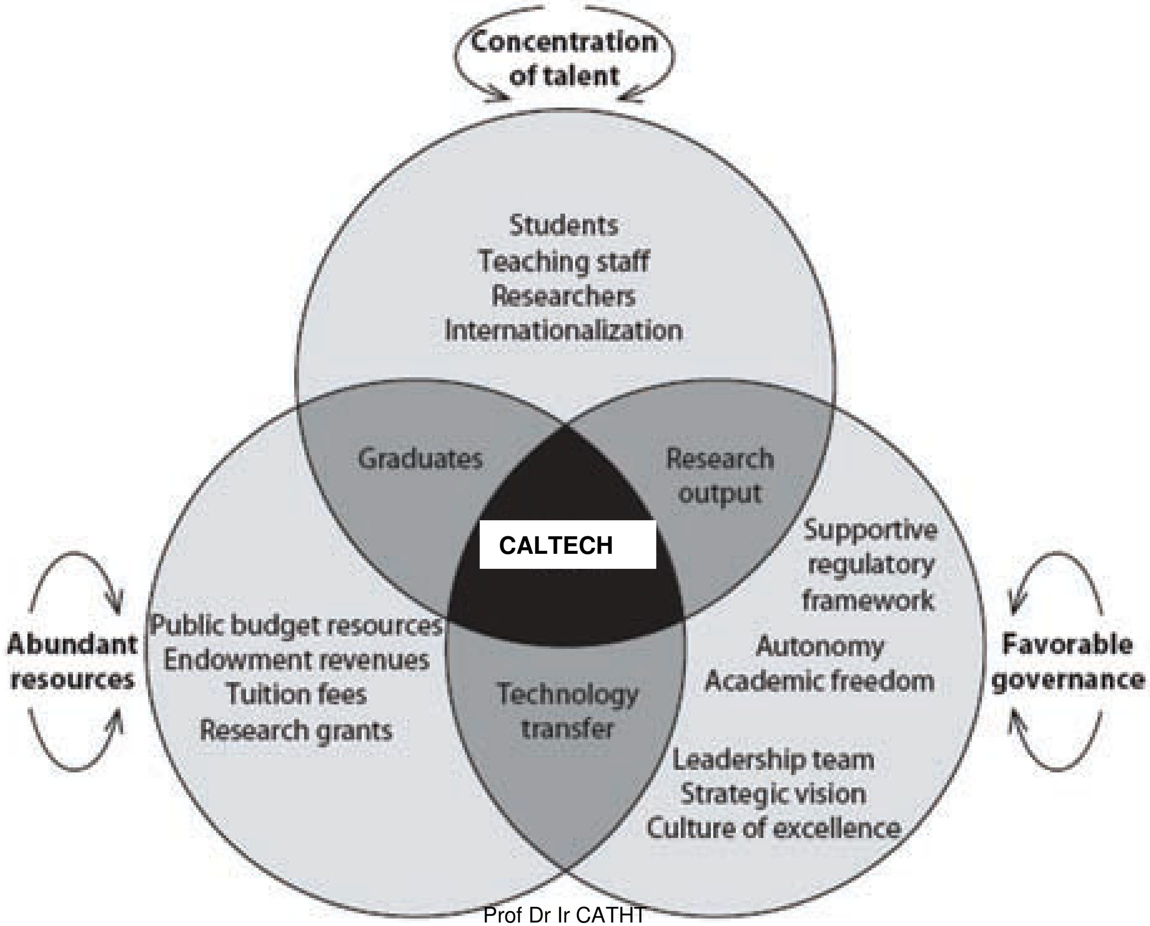
Research partnerships

Joint planning, implementation, evaluation of significant, long-term research program of mutual interest and benefit; specific, detailed, contractual arrangement governing relationship; both parties contribute substantively to research enterprise

In Summary:

- There is great diversity of an industry-university relationships and as yet **no standard well-tested model** for industrial support of university research has emerged. This is because of the differences in objectives, concern for proprietary rights, financial resources, and research sophistication of the industries involved.
- Properly set up, with understanding of each participant's interests and limitations, collaboration in research can be expected to lead to great mutual *benefit.*
- *Collaborations* based on one side, seeking specific answers to specific proprietary problems, however, and the other seeking financial support to keep academic wheels turning without proper consideration of educational objectives can only be expected to lead to mutual dissatisfaction.

Caltech Model: In Nutshell



Characteristics of Caltech: Alignment of key factors

- Highly sought graduates, leading-edge research, and technology transfer can essentially be attributed to three complementary sets of factors at play in Caltech:

  (a) a high concentration of talent (faculty and students),

  (b) abundant resources to offer a rich learning environment and to conduct advanced research, and

  (c) favorable governance features that encourage strategic vision, innovation, and flexibility and that enable institutions to make decisions and to manage resources without being encumbered by bureaucracy.

The Way Forward

Caltech Model is successful because it:

(1) Treats business people as allies and equals (also vice-versa);

(2) Encourages students to think about the business potential of their academic research and

(3) Resists “the temptation to monitor and regulate business relationships aggressively”.

Thank you