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NEWSLETTER OF THE AMERICAN SOCIOLOGICAL ASSOCIATION SECTION ON

# SCIENCE, KNOWLEDGE and TECHNOLOGY

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NEW OFFICERS. Chair, Susan Cozzens, (Science and Technology Studies, Rensselaer Polytechnic Institute, Troy, New York 12180, phone 518-276-6598 or 301-949-6345, fax 518-276-4871, E-mail USERFP2L@RPITSMTS); Chair-elect, Lowell Hargens, (Ohio State); Acting Secretary-Treasurer, Jim Peterson (Western Michigan University); New Council members: Joan Fujimura (Harvard University) and Chandra Mukerji (University of California at La Jolla). Continuing Council members: Mary Frank Fox (Pennsylvania State University), Rosa Haritos (Columbia University), Judith A. Perrolle (Northeastern University), Kathy Slobin (University of California, San Francisco), Peter Whalley (Loyola University). Congratulations to the new officers, and thanks to those whose terms have now expired: the past President, Henry Etzkowitz, and two past Council members, Tom Gieryn and Willie Pearson, Jr.

TWO SECTION MEMBERS HONORED: The Robert K. Merton Professional Award was given to Jack Ralph Kloppenburg, Jr. (University of Wisconsin-Madison) for his book First The Seed: The Political Economy of Plant Biotechnology, 1492-2000 (Cambridge University Press, 1988) and to Chandra Mukerji (University of California, San Diego) for her book A Fragile Power (Princeton University Press, 1990). These awards were given by the SKAT Section at the 1991 ASA meeting in Cincinnati. Congratulations to both authors. The awards committee included Willie Pearson, Jr. (Chair), Thomas F. Gieryn, and Adele Clarke. The Hacker/Mullins Student Award was not given to anyone because there were no nominees.

SKAT SECTION RENEWALS: ASA membership renewal notices were mailed out several weeks ago. If, in returning your renewal form, you inadvertently forgot to renew your membership in our section, it is not too late! Just fill in the special form below, and send it to the ASA office with your check. If you did renew your section membership, please give this form to a colleague or student who might be interested in joining us. Our section has exciting prospects, and ASA members with interests similar to ours should want to join. And, the more members we have, the more things we can do.

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APPLICATION
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Please enroll me for one year (1992) as a member of the ASA Section on Science, Knowledge and Technology. Enclosed is my check for

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PUBLICATION AVAILABLE: "Syllabi and Instructional Materials for Science and Technology," compiled by Stephen Zehr, is available from the ASA Teaching Resources Center, 1722 N St. NW, Washington DC 20036. Cost is $10.43 but SKAT members are eligible for a 10% discount, so they pay $9.39.

NEW JOURNAL: Public Understanding of Science is a new peer-reviewed journal devoted to research and scholarship in the public dimensions of science and technology. It represents an emerging inter-disciplinary field of growing interest to educationalists, historians, media analysts and sociologists. The journal covers all aspects of the inter-relationships between the public and science, technology and medicine, including: surveys of public understanding of and attitudes towards science and technology, science education, science in government and industry, popular representations of science and scientists, scientific lobbying, science in the arts, science in the media, public scientific controversies, science museum studies, science in advertising, science information services, anti-science, scientific and para-scientific belief systems, and appropriate technology. Public Understanding of Science will feature a Noticeboard, which will provide a news service to its readers. We would be interested to hear of forthcoming conferences and seminars, new research initiatives, exhibitions and publications. Readers can also use Noticeboard to call for information or invite collaboration. Items for Noticeboard should be submitted on paper only, either by post to Jane Gregory, Public Understanding of Science, Science Museum Library, London SW7 5NH, UK, or by fax on +(0)719388213. Items should

be brief (100 words maximum), and contain the full name and contact information for the individual or organisation concerned. Each item will be published in one language only, which can be either English, French or Spanish. Publication of items in Noticeboard is at the Editor's discretion. Public Understanding of Science is published quarterly; copy deadlines for the first volume are 20 September 1991 (publication January 1992), 10 January 1992 (publication April 1992), 3 April 1992 (publication July 1992), and 10 July 1992 (publication October 1992). Public Understanding of Science is published by IOP Publishing Ltd in association with the Science Museum, London, and edited by John Durant.

CALL FOR PAPERS: The SKAT program committee is calling for submissions for its sessions at the 1992 ASA meetings in Pittsburgh. Deadline: January 15, 1992. Papers on any topic within the section's scope are welcome. Possible special session topics include (1) comparative international analyses of science and technology, and (2) science, technology and the labor process. Send papers to Lowell Hargens, Department of Sociology, Ohio State University, Columbus, OH 43210. Please include telephone and fax numbers where you can be reached in late January.

EDITORIAL POSITION OPEN: Editor, Sociological Inquiry, the journal of Alpha Kappa Delta, the International Sociological Honor Society. Term of office is four years, beginning January, 1993. Applications will be reviewed as they arrive, and must be received by February 1, 1992 to receive full consideration. Send vita, statement of editorial philosophy, list of references, and indication of institutional support to: Professor Candace Clark, Department of Sociology, Montclair State College, Upper Montclair, New Jersey 07043.

## FUNDING OPPORTUNITIES FOR GRADUATE STUDENTS: REPORT ON AN ASA SESSION

Rosa Haritos
Columbia University

I am pleased to report that participants who attended the session on Funding Opportunities for Dissertations in Science, Knowledge and Technology found it very useful. Dr. Murray Webster, Director of the Sociology Program at NSF, spoke about Grants for Improving Doctoral Dissertation Research. Dr. Sara Beth Nerlove spoke on behalf of Rochelle Hollander for the Ethics and Value Studies Program at NSF.

Doctoral Dissertation Improvement Grants are offered once a year, the deadline being October 15th. Awards are made up to $5000. The review period is short: call four months after your submission and you'll know if it will be funded. The proposal is submitted through university channels and your advisor is the principal investigator. A panel reads the proposals and writes reviews so at the very least, this is an opportunity to get feedback from people who are working in your proposed field of study. Here are some tips offered by Webster:

The program is theoretically driven. Clearly state how and why your work is important to both generalists and specialists in the field.

Use the active voice. Use short sentences. The committee has many proposals to read in a short time. Don't waste time trying to impress them: get your point across quickly.

Clearly state what you plan to do and how you'll do it. If you plan to use a questionnaire or an interview guide, include it in the proposal. Discuss what you expect to find in light of your hypotheses and how your findings might fit into the general context of the field.

Finally, remember that this is a grant to *improve* your doctoral dissertation. It's in your best interest to send in a proposal during the early stages of your research: should it be rejected, you'll still have time to make revisions and re-submit.

For more information on grants to improve doctoral research write to Murray Webster, Director of Sociology, NSF, 1800 G Street NW, Room 336, Washington DC., 20550, (202)357-7802. Ask for NSF Flyer #89-32.

Sara Beth Nerlove talked about the Ethics and Values Studies Program (EVS), which is one component of the Studies in Science, Technology and Society Program at NSF. The other program focuses on Historical, Social and Philosophical Research in Science and Technology. (HSPR) HSPR is geared more for historical research in the sociology of knowledge, while EVS pays particular attention to the interactions between science and society. EVS funds work that examines ethical, policy and value aspects of science and the impact of these factors on society. It supports dissertations that examine scientific or professional controversies involving science and technology; values in scientific or engineering practice; normative issues that arise in decision making involving science and technology; policy issues in science and technology and so forth. The program funds research up to $15,000. Budgets cover a wide array of expenses: funds to travel to other universities to consult with "experts"in a given field, funds for data analysis such as interview transcription, funds for visiting research libraries and archives. Target dates for applications are February 1 and August 1 of every year. It takes six months to process a proposal. For more information contact Rochelle Hollander, Ethics and Values Studies Program, Room 312, NSF, Washing DC., 20550, (202)357-9894.

Other agencies also offer some assistance for dissertation research. Visit your local Office of Projects and Grants and ask to see the 1991 Directory of Research Grants. Check the subject index, either under "dissertation support" or a specific area of research (such as AIDS, Alcoholism etc.). The directory provides an abstract of each program, requirements and deadlines.

# Academic-Industry Relations

Henry Etzkowitz

From September 1st to 6th 1991 a group of 50 academics and practitioners, drawn from across the world divides of North/South and East/West, met at the Hotel Villa del Mare in Acquafredda, Italy for a NATO sponsored Advanced Research Workshop on Academic-Industry Relations. During the first week of September, two years of planning, writing and fund raising came to fruition at this seaside resort in Italy's mountainous Basilicata province, south of Salerno.

The road to Acquafredda began in Irvine, California during the fall 1989 meetings of the Society for the Social Study of Science. Peter Healey, co-Director of the British Science Policy Support Group (SPSG), and I found each other at the end of a set of two sessions on academic-industry relations that I had organized. We both had the same idea. The time was right to organize a workshop bringing together scholars from around the world who were working on the various topics of academic-industry relations such as modes of collaboration, interdisciplinary research centers, technology transfer, impacts on research agendas, interorganizational relations, conflicts of interest, and industrial and science policy.

The researchers and practitioners from 17 countries and the European Community, who arrived in Acquafredda on August 31st for a pre-conference excursion to Pompeii and Vesuvius, were drawn from a variety of academic, industrial and governmental spheres. Our charge was to determine what common ground for analysis and practice existed, given widely different economic, political and academic systems. The common denominator was involvement as a researcher or practitioner with the causes and effects of collaboration between academic research and industry. A typical session included a mix of researchers and practitioners, from academia, industry and government presenting, each paired with a commentator.

## 1 Evolution or Revolution?

A debate soon arose over whether academic-industry relations represent evolutionary or revolutionary change in academic structures and goals?[1] Do the technology transfer offices, science parks, research contracts with mult-national firms and faculty spinoff firms augur the emergence of a new function and corresponding organizational structure within the university? Has the university become an engine of science based regional economic growth or are these activities merely an extension of the university's traditional service function? Are science faculty shifting their motivational structure from building reputations on collegial recognition and publications to a more capacious normative code that encompasses creating economic activities from research findings? Do researchers demonstrate increased sensitivity to the technological implications of their research and greater willingness to seek out and expand upon such implications? Are they abandoning disinterest in the economic implications of their research in favor of making results available to university administrative offices to patent or even to organize a spin-off firm themselves, with or without their school's involvement and assistance? Are these activities occurring at a significant rate in the science and engineering departments of individual universities? Are they limited to a few schools or are they becoming widespread throughout the research university world? Has "entrepreneurial science" become well enough accepted to constitute taken for granted and even favorably viewed activities meriting academic advance? If this latter evaluation is the case, should normative change rather than deviance be the framework for sociological analysis of academic-industry relations?

The "second revolution" thesis that these activities are being integrated into the university as a

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[1]Andrew Webster and Henry Etzkowitz "Academic-Industry Relations: The Second Academic Revolution?" London: Science Policy Support Group, 1991.

distinct academic function is an extension of the historical account of universities assuming a research function, beginning in the late nineteenth century, distinct from their teaching function: the so-called academic revolution.[2] By the mid-point of the workshop the evolution/revolution question was reformulated. It was seen not so much as an issue of whether these changes were occurring discretely or as a sharp break with existing practice. Rather, did they, in sum, represent a new function for the university, that of economic and social development, or were they merely an extension of existing modes of research and teaching?

Should the university take on a direct role in economic and social development, as a distinct academic function along with teaching and research? Sociologist Lois DeFleur, President of SUNY Binghamton, noted in a recent article that federal legislation has authorized support for educational institutions to identify and disseminate effective partnership models for regional economic development.[3] Despite the authorization, Title 11 of the Higher Education Amendments of 1986 has yet to be funded although there are indications that this may happen in a modest way during the current session of Congress. Indeed, Marquette University in Milwaukee has announced an urban redevelopment plan, relying heavily on the social sciences, that could easily consume all of the twenty million in funds projected to be allocated for this program.[4] Although university involvement in social development remains to be funded by the federal government, academic participation in programs for economic development have become commonplace on the state level in recent years.[5]

## 2 Technology Transfer

Several speakers discussed the range of relationships universities and companies have developed with each other. Eugene Schuyler, Director of Technology Transfer at SUNY, outlined new trends in patenting and licensing. Andrew Webster of Anglia Polytechnic discussed the emergence of "hybrid coalitions" of joint research schemes involving academics and their counterparts in industry as part of strategic alliances companies are making with universities while Fiona Roberts, Director of External Scientific Relations for the Glaxo Corporation explained what her company expected from its interactions with academia. Norman Ellmore of ICI also portrayed the view from industry of liason with universities while John van Eijk of the Delft University of Technology viewed the situation from the perspective of the academic liason office. Paul Hoch of Nottingham discussed the potential of interdisciplinary research centers to supercede more traditional modes of academic research; they might. Bob Kargon of Johns Hopkins discussed the varied roles of real estate developers and political leaders in developing North Carolina's Research Triangle; universities were notably absent as key players in the early years. Rikard Stankiewicz of Lund drew upon his extensive research on science parks to discuss the question of their impact on regional economic development; the jury is still out. Despite some skepticism, the effort continues, often in more sophisticated and highly organized forms. Maggie Sheen of the University of Strathclyde described how at her university technology transfer efforts are supported by research on the phenomenon while Stelle Manne of the Stevens Institute of Technology reported that several New Jersey universities have organized a consortium to attain a critical mass in their technology transfer efforts.

Diana Hicks, of the University of Sussex's Science Policy Research Unit (SPRU), discussed

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[2]See Christopher Jencks and David Riesman: The Academic Revolution New York: Doubleday, 1969.

[3]See Lois DeFleur "Transforming the Ivory Tower" SUNY Research May, 1991 pp. 8-9.

[4]See "Universities Become Full Partners in the South" for a discussion of the role of the University of Alabama, Birmingham in the black community. New York Times August 13, 1991. p. A12.

[5]Henry Etzkowitz "Regional Industrial and Science Policy in the United States" Science and Technology Policy April, 1991.

the continuing importance of the oldest form of academic-industry relationship. Informal ties between researchers in university and industry are still the primary academic-industry linkage mechanism in Japan. Dr. Toshiaki Ikoma of the Institute of Industrial Science at the University of Tokyo expanded upon this theme and showed how such connections could be transformed into an impressive organizational structure. Building upon the credibility he had gained with Japanese companies in the semi-conductor industry by solving quality control problems in chip production, Ikoma was able to call upon these companies to contribute signficant funds to a new academic basic research consortium. The company decisions to join were made quickly and without elaborate review. In his talk Ikoma expanded on the relationship he believed should exit between academia and industry, each in its separate sphere. In addition, he suggested a notion of pre-basic research to be performed in the universities in which the strategic direction of basic research is the issue. Industrial development work also provides fundamental issues for basic researchers to study such as the questions that came out of his work on manufacturing quality control in micro-electronic chips. In this model the activities of both university and industry are extended. At first glance the extension of pre-basic from basic research appears to conform to the traditional linear model of research and development, with a unidirectional flow from basic to applied research to development work. But the casting of problems from industrial practice into the academy for investigation at the basic level suggests a model of R&D in which stages are folded over on one another in a spiral-like fashion compatible with feedback and "neural net" models of an interactive relationship among science, technology and the economy. Although Ikoma's model of academic-industry relations is innovative in many respects, it is limited in its application to the relationship between large corporations and the university. It leaves out the potential of the university as a generator of new small companies from academic research, a distinctly American phenomenon and growing elsewhere in the world, but decidedly not a Japanese requsite of academic-industry relations, at least not yet.

Several participants, from both academic and industrial backgrounds, analyzed the role of university teaching in technology transfer, calling attention to it in the dictum that 'technology moves through people.' Dick Bond, speaking from industrial experience, viewed the training function of universities as still the most important one for industry and this view was accepted by most academics. Mike Gibbons of Manchester University's PREST proposed an innovative extension of that teaching role through the preparation of persons skilled in the activities of technology transfer as a major new degree program and educational sphere for universities. Indeed, the Centro para la Innovacion Technologica (CIT) of the Autonomous University of Mexico (UNAM) has training programs for technology transfer officers, typically directed to B.A. engineering graduates. Elsa Blum, CIT sociologist, described how the training program, originally developed to staff the CIT's own technology transfer and licensing activities, is now being utilized by other Latin Americans.

Despite the emphasis on training there was also broad recognition that academic research is increasingly of use to industry. The phenomenon of spinoff firms and contracts with large corporations made this connection manifest but important differences between large and small firms were noted also. David Blumenthal of Harvard University's Brigham and Womens Hospital suggested that relationships with large firms were less disruptive to the traditional academic ethos than involvement with small firms. Undercapitalized small firms are often under pressure to get results quickly from research that they sponsor in the university, leading them to induce professors and graduate students to focus on short term results rather than on long term goals. On the other hand, some professors view firms that they establish as a way of separating development work that comes out of their research from the research itself, thus reducing pressures on themselves and their students to develop technology inside the university. Even those schools concerned about the negative pressures that small firms may exert on academic laboratories still want to capture the long-term equity that firms can generate and want to find ways to regulate rather than forbid such firms. To evaluate the effects of small firms on academic laboratories, Brigham and Womens Hospital included in its contract with two such firms provisions for an independent audit of the effects of firm interaction on the hospital's researchers.

Spinoff firms may have more significant long term payoffs for the university in contrast to

what may turn out to be initially large but relatively short term financial arrangements with large corporations. The agreements between the Monsanto Corporation and Harvard and Washington Universities have lapsed. These contracts may represent a temporary strategy on the part of a firm to immerse itself in a new research area. As soon as a company brings its own competence up to speed it may find such relationships with academia superfluous. June Clark of Oxford University discussed her university's assessment of the pros and cons of its recent agreement with the Squibb Drug Company. Since the sum was large enough to support significant new construction as well as research activities, with a reasonably long notice period for ending the agreement, it was felt worthwhile to take the risk of expanding activities and accepting the danger of being left without support down the road. As in most such agreements research funds were provided for an area that the department already had signficant expertise and interest, with the company having right of first refusal to any useful results that arise from the research it has supported. In an era when research support is increasingly difficult to obtain, large industrial research contracts are viewed as the closest thing to a government block grant program, now being replaced by individual grants competitions in many countries.

## 3 Conflicts of Interest

Karen Lewis, chair of the Department of Educational Policy and Administration at the University of Minnesota, called attention to Robert K. Merton's classic formulation of the "norms of science" as a baseline from which to analyze the issue of university-industry relations. Did they represent deviant behavior or normative change in academic science? From her research with David Blumenthal and Michael Gluck, she noted that professorial involvement in entrepreneurial activities in the mid-1980's could be identified as a major phenomenon at only six universities.[6]

However, in some departments such as biology at MIT and Stanford, industrial ties have become virtually universal. Such ties are also a growing phenomenon at liberal arts universities previously distant from entrepreneurialism such as Columbia and the University of Colorado, Boulder. They are promoted by academic administrations to accrue funds to the campus, by state governments to stimulate local economies and inadvertantly by departments hiring professors from leading entrepreneurial universities. Despite opposition from some scientists and humanists, an entrepreneurial culture is taking hold throughout the research university system in high-technology related academic fields, including theoretical chemistry.[7]

Conflicts of interest tend to arise during the early phase of the introduction of an industrial tie. At this point traditional academic norms are strained, before being reinterpreted to accommodate change. Conflict of interest disputes are typically superceded by regulation of the new tie. During the early 1930's, MIT debated the propriety of professors' patenting the results of their research and closed the decade, having worked out a format for patenting academic research that it believed was in accordance with the public interest. MIT negotiated an arrangement with the Research Corporation, to act as an intermediary between the university and industry. The corporation sought out research on campus to patent and market to appropriate companies instead of the professor or university doing it themselves. In the early 1980's, Harvard drew back from going into partnership with one of its professors to form a biotechnology firm but did not reject such activities in principle. Indeed, Harvard's president, Derek Bok, reserved the option to find a way to achieve a similar goal in the future. By the end of the decade the university had worked out a formula for the Harvard Corporation, a governing and business arm of the university, to supply venture capital and otherwise participate in organizing new firms based on faculty research. Again, the arrangement distanced the academic sector of the university from commercial activity. Other schools have eschewed such stratagems in favor of integrating

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[6]David Blumenthal, M. Gluck, K.S. Lewis, and D. Wise. 1986. "University-Industry Research Relationships in Biotechnology: Implications for the University," Science 232 (13 June), pp. 1361-1366.

[7]See Henry Etzkowitz. 1991. "Small Science in Crisis" A Report to the National Science Foundation, August 15.

academic and commercial projects.[8] On many campuses the propriety of new forms of academic-industry relations, such as participation in the organization of spin-off firms that were contested in the United States in the early 1980's, had become accepted or at least viewed as non-controversial by the close of the decade. By the beginning of the 1990's, entrepreneurial professors who had earlier been subject to charges of conflict of obligation as a result of their involvement in founding a firm, were asked to chair their department. Colleagues aparrently expected that their new chair's commercial experience would help them gain increased support from the university administration as well as from industrial firms. Having negotiated with venture capitalists and started up research programs with large budgets, these individuals typically return to academia from their firms with plans for departmental growth, center formation and industry ties that are on a grand scale.

As industrial ties became more accepted in universities, government authorities and public interest groups have raised new questions about their propriety. In part, this renewal of concern is due to international competition and fears of loss of intellectual property to foreign firms through industrial ties. Concern has also been expressed that the distinctive qualities of universities as independent centers of expertise are also being compromised. Formerly an internal academic matter even when highly publicized, conflicts of interest have become a political issue on the national scene. This is especially the case when academic-industry issues are overlayed by disputes arising from the new commercial activities of national laboratories.

Drawing on the legal analysis of conflict of interest emanating from the lawyer client relationship, philosopher Vivian Weil, Director of the Illinois Institute of Technology's Center for the Study of Professional Ethics presented a typology of responses to conflict of interest defined as interference with an individual's independent judgment. I suggest that whereas the Bar Association's definition of conflict of interest rests on a presumption of an isolated dyad of independent individuals, the academic professsor-graduate student relationship is one in which the student is inevitably strongly dependent on the professor's judgment, even given the presence of countervailing influences through the presence of other faculty members on the dissertation committee. Indeed, the professor-student relationship can be seen as constituted on the basis of a conflict of interest between directing a student's independent intellectual progress and capturing the output from it through standard forms of academic recognition. There are, of course, also confluences of interest between mentor and mentee. Nevertheless, interests affecting a professors judgment exist even without the overlay of the contentious issue of disposition of intellectual property rights. These interferences with independence of judgment cannot likely be done away with although they certainly can be regulated.

## 4 Uneven Development

There was a range of presentations on the experience of first, second and third world countries with academic-industry relations including Mexico, Brazil, Hungary, Romania and Portugal. A debate among Eastern Europeans arose on the future of the national scientific academies of these countries. The academy system had been created during the early post-war era on the Soviet model to isolate groups of researchers from each other and from university students as form of social control. According to one point of view these organizations represent a significant social investment that should be utilized even as it is reformed, with some research resources allocated to the universities.

Were the academies still a useful scientific organizational resource inherited from a previous era that could be turned to new tasks through joint ventures with the west, or as Bogdan Costea of Romania argued, a bureaucratic vestige of the past to be abandoned in favor of first world modes of university research practice? Perhaps ironically even as they are under attack in

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[8]Henry Etzkowitz. 1990. "University-Industry Relations: Models of Integration and Separation" Proceedings of the 15th Annual AAAS Colloquium on Science and Technology Policy Washington D.C.: American Association for the Advancement of Science.

Eastern Europe, academy-like structures are being created at present in the United States and United Kingdom in the form of interdisciplinary research centers in order to concentrate scattered research resources.

Participants from widely different countries found that they shared common issues in developing and evaluating academic-industry relations. As Katalin Balazs of the Hungarian Academy of Sciences put it in a post-conference fax to the organizers,"...the break discussions touching the problem of the Latin American, South European countries lead me to the idea that it could be our common interest to find the similar features, strctures, reasons, to compare and evaluate in our policy making ideas. For example, in these discusssions we realized that in a 'follower' country the role of basic science is different from the most developed ones, we mainly agreed it is a 'cultural' role. Or: the dependence in technology creates similarities among very different countries, like Australia and Hungary." Beatriz Ruivo of Portugal reported a similar phenomenon in the science and technology policy of a peripheral first world country.

In the course of these presentations a theme, if not a law, emerged of "uneven development." In addition to a continuum from teaching to research to economic development, there appeared to be academic systems that were moving directly into economic development activities before developing much of a research base and other systems with a previous formal commitment to industrial relations that were now engaged in establishing autonomous research universities. Riccardo Viale and Sergio Campodall'Orto of the Fondazione Roselli and Claudia Roveda of the Italian National Research Council discussed the new Italian legal framework for closer involvement of universities with industry. However, many Italian universities lack extensive research capabilities since public research has traditionally been located in independent, often quite small, government sponsored institutes. So, many Italian universities that have yet to undergo the first academic revolution are being thrust into the second. New groups of research institutes are being constructed, some within or adjacent to existing universities while other groups of institutes are being located at separate sites, often due to land shortages near older universities.

Conversely, in Eastern European countries university-industry relations were mandated as an ideological requirement of the previous regime on the grounds that the intelligentsia should assist the working class. An outcome of the current political upheavels is, on the one hand, the development of enhanced research capabilities in the universities free of governmental controls. In addition, the technical universities are partly supported by new contracts with industry. Previously ties with industry were merely an ideological requirement necessary for a research group to justify its existence. These arrangements had little content since industry tended not to be innovative during the communist period and thus required few new inputs of research. Industry must now improve its old products and develop new products in order to survive. Thus, ties to universities take on a material basis with a real meaning since new ideas and new research findings are used in developing competitive products. A variety of forms of academic-industry relations including science parks and spin-off firms have been reported in Hungary and the Soviet Union.

## 5 Regional Development

Contradictions at the regional level of academic-industry relations became apparent during workshop discussions. Theresa Walker of New York State's Science and Technology Foundation, presented New York's Center for Advanced Technology (CAT) program of state funded academic research centers in selected technology areas. She noted that it was an insufficient industrial policy to put resources into a university to develop a technology transfer capability if there was not an appropriate industrial sector capable of receiving the results. Under these conditions, technology would flow out of the university to other regions and even other countries since technology transfer units will make deals wherever they can to justify their existence and perform their function. Thus, a more sophisticated notion of regional science based economic development is required than simply giving faculty of a local university the incentive to make their research technologically relevant and equipping the university with a technology transfer office or a research center capable of producing technologies with industrial uses.

Supply side inputs can only be part of a regional development strategy. These implications were especially clear for New York State where a network of university research centers has been created that often lack a local industrial base capable of receiving its efforts. Thus, it is necessary to tailor academic-industry relations to the needs of an existing industrial base, if available and capable of utilizing them. Alternatively, new industrial bases must be created, such as biotechnology companies on Long Island, through a consortium of existing major research laboratories in the area, as SUNY's Gene Schuyler suggested. Academic research could then flow into industry. Otherwise regional initiatives to support commercializaion of academic research may have little or no local economic effect if the region lacks an infrastructure to utilize its research resources.[9]

Technology capture was also an issue on the national level, especially for the United States. Concern was expressed that the United States paid for a disproportionate share of the world's basic research while much of the technological spinoffs of this research accrued to the benefit of other countries, Japan in particular. It was pointed out that other countries, including Japan, are increasing their expenditures for basic research. Moreover, much of the U.S. basic research establishment is dependent upon persons educated in the third world and elsewhere for its human capital. Nevertheless, ressentiment over capture of intellectual property is a live and growing issue. Ironically, the U.S. federal government forswears the direct role that other national governments, such as Japan and Italy, have taken in developing new industrial infrastructures to commercialize results from public sector research. The United States abjures this approach on the grounds that "picking winners" is an inappropriate role for government and best left to the private sector. Although the United States refuses to directly intervene it has, during the past fifteen years, put into place an indirect industrial policy. For example, universities are encouraged to institute technology transfer programs, thereby acting as a "surrogate" for a national industrial policy. State governments more directly dependent on jobs and tax revenues from industrial development lack such ideological scruples and, irrespective of party, have virtually unaninmously moved to adopt policies to support science based economic growth. These policies have attracted attention in other countries and regional initiatives have been taken in Germany and elsewhere in Europe. Indeed, Hugh Logue, the Commissioner for Science Policy of the European Community, stated that formulating science based industrial policy has become a major priority for the Community in addressing issues of regional disparity in Europe.

## 6 Conclusion: Beyond Capitalism and Socialism

The framework of the conference underwent a subtle shift during the five days from a presumption of a bipolar relationship between universities and industry to a multi-polar perspective in which governmental authorities at several levels (international, national and regional) were viewed as significant actors along with changes within civil society that were transforming the relations among actors from different sectors: academic, industry and government. Indeed these sectors could no longer be seen as separate spheres since the legitimating sector or the political sphere was now engaged in promoting economic activities based on knowledge even in so-called capitalist societies; universities were involved in creating their own industrial sector through spin-off firms and companies were producing knowledge and engaging in training in formats that were increasingly university-like.

Sonia Gomensoro of SPRU and the University of Rio de Janiero pointed to changes in society transcending the replication of academic-industry contracts in different countries analyzed in her dissertation. She noted that industrial practice is increasingly knowledge based, requiring improved levels of education for populations in order for them to participate in the economy. Indeed, Ary Plonski of the University of Sao Paulo noted that his country was becoming Bel-

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[9]See Henry Etzkowitz "The Making of an Entrepreneurial University: The Traffic Among MIT, Industry and the Military, 1860-1960" in E. Mendelsohn, M.R. Smith and Peter Weingart eds. Science and the Military Dordrecht: Reidel, 1988, for a discussion of how academic, political and business leaders addressed this problem in New England during the 1930's and 40's.

India, an amalgam of Belgium and India. Brazil is increasingly divided into separate entities, one highly knowledge intensive and one not. Even the two paradigmatic countries exhibit similar internal tendencies as do the United States and the United Kingdom, with their parallel tracks of de-industrializing older cities like Detroit and Liverpool and newly emerging university-based high technology towns such as Boulder, Colorado, Ann Arbor, Michigan and Cambridge, England. Oxford, England and Cambridge, Massachussetts are, respectively in the early and later stages of a dual track, losing older industrial firms and gaining new knowledge based industries, with some recyclying of buildings and re-employment of workers.

Beyond these specific trends, the larger significance of science based economic development is that it supercedes a working class based on industrial labor and traditional forms of socialism. Indeed knowledge as the basis of industrial development also supercedes traditional concepts of capital and capitalism. Post industrial society has been expected to rest on the growth of services. But services have to be supported by economic growth, a proposition that governmental units from New York City to Sweden are being forced to confront. It is presumed that Sweden requires a 3% rate of real growth to support its welfare state. Lack of such growth and voter discontent with high taxes could result in dismantlement as, indeed, one new party calls for. Similar issues of economic and social development exist in the first, second and third worlds, despite historical differences among economic, political and academic systems.

Capital and labor, traditionally organized, are insufficient to support economic growth in the coming era, especially in the context of environmental constraints. Even without coining a neologism of "knowledgism" to denote this transcendence of socialism and capitalism, the investigation of academic-industry relations has led some of us to conclude that we are at the threshold of a new common form of economic and social development that cross-cuts the traditional geographical divisions of North/South, East/West and the divergent political philosophies heretofore associated with these world areas.

## A MESSAGE FROM THE EDITOR

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