US Industrial Scientists

Alienation and Elitism

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Structural changes in the capitalist economy in the US brought about by globalisation are leading to a decline in the status of industrial scientists. With the restructuring of corporate R and D, research is entirely driven by market forces and research goals defined by market needs. An essay on the changing face of corporate R and D based on interviews with industrial scientists.

Introduction

MARXIST scholars in the US have placed professionals in the capitalist political economy and analysed their status in terms of capitalist relations of production. Marx argued that with the development of productive forces beyond the mode of primitive communism, the society is divided into classes, having different places in the production process, different relationships to the means of production, and different methods of distribution of products. A capitalist society is divided into two major antagonistic classes: a small capitalist class which owns the means of production and the labour power of workers, and a large working class which does not own the means of production and hence sells its labour power to the capitalists. The ownership of both the means of production and labour power entitles the capitalist class to appropriate the surplus labour of the working class.

Marxist scholars see professionals as the working class proletariat since they possess no capital and work for others. Derber (1982) predicted that eventually, professionals will wither away through the continual process of proletarianisation as happened to the independent artisans and craft workers at the turn of the century. Braverman (1974) argued that professionals, like the working class, do not possess economic or occupational independence, and access to the labour process or the means of production outside their employment. Larson (1977) suggested that professionals are increasingly providing their services to state and corporate markets which, in turn, transform their status from 'free' to 'dependent'. McKinlay (1982) proposed that professionals working within bureaucracies are divested of control over certain prerogatives such as the qualifications for membership, the content of training, autonomy regarding the terms and content of work, the objects of labour, the tools of labour, the means of labour, and the amount and rate of remuneration for labour. Carchedi (1975a, 1975b) argued that the new middle class experiences de-qualification of labour by having more skills than required to perform the new simpler operations due to continuous economic and technical changes. Oppenheimer (1973) suggested that professionals face de-skilling as industry reduces cost, increases profit, and enhances control over the labour process.

In an interview with 47 industrial scientists of centralised corporate research and development (R and D) laboratories in the US, I found that structural changes in the capitalist economy brought by globalisation are leading to a declining status for industrial scientists. Although scientists are highly qualified, their research is being driven by market forces with the restructuring of corporate R and D, not vice versa. However, the scientists do not consider themselves as ever being reduced to the standards of the working class. I discuss the disparity between objective reality and subjective perception of scientists within the Marxist class theory.

Restructuring Corporate Laboratory

The context for deterioration of US industrial scientists is recent changes in the global economy. The new reality is that US manufacturing companies are operating in a global economy where over 70 per cent of the goods they produce compete with merchandise from abroad. There has been a shift from a situation in which a high technological capability was uncommon to a situation where high technology capability is well-distributed among many countries. As hi-tech industries became an important component of the US gross economic output and its standard of living, the US industries slowly lost the status of a leading producer of hi-tech products abroad and at home. In the 1980s, US hi-tech industries were faced with intense competition from Japan and Europe. By the 1990s, competition opened on another front, from newly industrialised economies such as South Korea and Taiwan. Since the early 1980s, the US has been unable to stay ahead technologically and commercially in those goods and services that are likely to constitute a larger share of value added in the future [Reich 1983; Cohen and Zysman 1987; Dertouzos, Lester and Solow 1989]. After making major technological advances in products such as transistors, radios, colour televisions, video cassette recorders, steel, automobiles, and numerically controlled machine tools, the US lost these markets to foreign producers.

Many American companies are dealing with the problem of their inability to compete in the global market with financial restructuring such as leveraged buy-outs, mergers and acquisitions, and hostile and friendly take-overs [Adams and Brock 1987; Academy 1990]. These strategies are designed to generate higher values for shareholders. American companies in the existing financial environment are rather vulnerable to take-over if their stock price stays persistently below the breakup value. There is more emphasis in companies investing in stock buy-outs than investing in research.

The growth of US industrial R and D expenditures has slowed in inflation-adjusted dollars since the mid-1980s. From 1979 to 1984, industrial R and D expenditures in 1987 constant dollars grew from $ 58,271 million to $ 89,236 million, an average annual increase of 7.4 per cent. However, the growth rate of industrial R and D expenditures was reduced to 3 per cent per year during 1984-89. In 1989, constant dollar expenditures actually declined (for the first time in 14 years). Since then industrial R and D expenditures have continued to decline in constant dollars, from $ 93,875 million in 1989 to $ 90,711 million in 1993 [NSF 1993:90, 333]. During the entire 1985-93 period, industrial R and D expenditures have been virtually flat. Since 1991, IBM, AT and T, General Electric, Kodak, Texaco, and Xerox have cut down $ 1.75 billion, $ 500 million, $ 500 million, $ 200 million, $ 90 million, $ 50 million, respectively, from their annual R and D budget [Cauley 1995; B1].

In addition to these declines in industrial R and D expenditures, many leading companies have been involved in replacing what I call the autonomous model for their centralised corporate laboratories, and implementing a new research strategy, what I call the linkage model [Varma 1995]. Under the autonomous model, corporate laboratory was considered crucial for the company's

growth and there was stability in the funding of research. Corporate laboratories received most of their funds by a flat tax on the sales or profits of the various business divisions of the company. Scientists and managers selected research projects on the basis of generic interests of the company, technical feasibility, and scientific breakthroughs relevant to the company. Corporate laboratories enjoyed a large degree of autonomy from the rest of the company in choosing research projects. Many R and D managers supported exploratory long-term research if they believed that the proposed research results would be eventually beneficial to the company.

Under this model, many corporate R and D labs produced promising research results, which changed the face of these companies. General Electric lab invented central electricity generation, motion picture systems, phonographs, incandescent clectric lamps, radio, and X-rays. Xerox's PARC lab invented laser printing and on-screen icons. IBM transformed itself from a typewriter company into the world's most important provider of powerful office technology. The Bell Labs invented the cellular technology, switching networks, the transistor, and the satellite. Du Pont converted itself from an explosives manufacturer into a large chemical company by inventing nylon and the complex technology to manufacture synthetic fibres, synthetic rubbers, fluorocarbons, and safety glass.

Yet, many of the results produced by corporate R and D were not converted into useful products and processes [Florida and Kenney 1990; Smith and Alexander 1993]. There are various barriers in utilising research results from R and D labs [Sheth and Ram 1990]. Consequently, since the mid-1980s many leading corporate laboratories are implementing what I call the linkage model [Varma 1995]. Under the linkage model, most of research is being linked directly to development, engineering, and manufacturing known as business divisions. Most of research funds are being generated by the company's business divisions. In collaboration and consultation with business division people, R and D managers and scientists select projects that are closely aligned to the company's existing products and processes. They depend on contracts from different business divisions of the company for their research efforts. Business division managers fund projects which deal with their specific problems, and are short-term. Since projects are financed by business people, and done specifically for their division, it is assumed that they would receive the developed technology and utilise research results. For instances, at General Electric corporate R and D, two-thirds of the budget is funded from its business divisions. Xerox's PARC Lab now gets detailed contracts from the company's product divisions. The Bell Labs is shifting its focus to information science to address customer's needs in its businesses. The IBM research lab's staff of scientists has been cut by nearly 20 per cent and the number pursuing basic research by half.

What Have Scientists Lost?

As many leading corporations are replacing the autonomous model of research with the linkage model, immiseration of industrial scientists is taking place [Varma and Worthington 1995]. The autonomous model was based on the assumption that scientists work best when they have significant input and their projects are not dictated by others. Consequently, scientists had autonomy to generate research projects. It was rarely the case that managers would specifically tell scientists what to do. The managerial challenge was to get scientists interested in particular areas. Under the linkage model, scientists are losing control over project selection process. Scientists either have to look at the business divisions to find out what problems need to be solved, or they are informed by business managers about the work that needs to be done.

Formerly, scientists generated research projects on the basis of technical interests which remained within the general goals of their company. Managers supported projects on the basis of their intuition about the fit with company's goals, benefits of the proposed technical knowledge, track record of scientists, and cost. Now scientists' research can no longer be only potentially related to the company's products and processes. Managers fund projects mostly on the basis of business interests that have displaced technical criteria. The impact on problem formation is direct. As one scientist said: "Three or four years ago, my manager told me that [the company] is not going to support my line of work. So I had to move to [current] area which has more funds." Scientists' real focus has become "where the money is coming from and what the needs of people who are funding the research are."

Prior to the linkage model, research was supervised by R and D managers who had degrees in science or engineering. It was believed that only such managers could appreciate the research process and understand the particulars of a project. Even with technical managers, scientists faced a problem in justifying projects if those managers had expertise other than in the area concerned. Such managers could not make a technical assessment of scientists' work. With the linkage model, scientists have to deal with business managers as well as their R and D managers to get projects funded. Business division managers have expertise in finance, business, accounting, budgeting, marketing, and so on. They support projects on the basis of cost-effectiveness rather than technical feasibility. Now scientists are having a hard time to debate the scientific and technical merits of their research projects.

Under the autonomous model, many R and D managers had long-term perspectives. They believed that research on fast-moving technologies of generic interest to the company would be profitable in the long run. As a result, scientists were able to convince their managers to support basic, long-term, research projects. With the implementation of the linkage model, scientists cannot get funding from business division managers unless their proposals are addressing specific problems of business divisions and are short term. R and D managers are unable to support long-range scientific research because there is a pressure on them to show immediate financial returns. Thus, there is a major alteration in the relation of scientific knowledge to production. Where, under the autonomous model, scientific innovations created their own markets, under the linkage model the demands of the market limit scientific innovation. One scientist said: "People in business would like to do exactly what they have been doing, that is modifying the equipment...They don't want to consider anything which will be useful to them in a few years."

Research is now conducted under short-term contracts. If scientists do not have funds for their projects, then they have to move to other projects. Scientists with inadequate funds are required to work with scientists with more funds. Such shifting of scientists from one project to another is often damaging to their career, as well as to their professional identity. Their career accomplishments and knowledge in a given area are going unnoticed and untested. As one scientist said: "Some of my colleagues left for [academia] because they were unable to switch to the area which had more money." Scientists, who did mostly research prior to the restructuring, now have to spend a significant amount of their time doing marketing for their projects. The funding process which came with the restructuring, forces scientists to take the new role of 'salesperson' in order to acquire funds from business divisions.

Furthermore, scientists are driven to have too many projects to raise funds. Often, such projects are different from each other in the sense that there is no underlying common theme. Now, scientists have to diversify, which is not healthy for their careers and the quality of research. One overburdened scientist complained: "At this point I have no other choice than to take two major and two minor projects. Two of these projects are barely related to each other. How can I do my best on these projects?" Reduction

in R and D funds means fewer technicians and less resources are being assigned to scientists than had been in the past. However, the number of projects being carried out in a corporate laboratory has hardly changed, and the workload of scientists has not decreased. As a result, in addition to traditional research responsibilities, the scientists' time is taxed further by having to pitch projects to funders and complete the work which was performed earlier by technicians. The reward system has also changed with the restructuring. Now scientists are being recognised by managers if they have generated financial support for their projects rather than research results, which was the case in prior years. Scientific contributions are still appreciated under the linkage model; but, they need to have a financial backing.

Interviews with scientists provided information that substantiated some aspects of the Marxist theory of the proletarianisation of professionals. There has been a deterioration in the scientists' working conditions as their research time is divided by the competition for project funding, and by decreased funding for laboratory technicians. Their expertise is sacrificed as they labour to sell ideas already limited by cost effectiveness. Industrial scientists have always been subject to some organisational control, but they worked under conditions that gave them comparatively greater autonomy than found in other departments. Earlier they were autonomous enough to perform research in accord with their own experimental designs, and without direct managerial supervision. Today, scientists' work is controlled directly through the allocation of increasingly scarce research funds. Research designs now follow funding as scientists try to make do with less resources, less time, and less autonomy. Yet, scientists do not believe that they will ever be proletarianised because they will remain different from non-technical workers.

These scientists attached more importance to the differences between them and non-technical workers than to the similarities. The general view of the scientists was: "It doesn't really matter that I work for the company, get a salary, and report to my manager...I differ because I earn more money, I am technically qualified, there is more prestige attached to my job, and I have lots of freedom."

Almost all scientists distinguished themselves from non-technical workers on the basis of their advanced degree. Scientists belong to occupations which demand highly specialised knowledge and skill acquired by prolonged education that is certified by an university or a research institute. Their knowledge is formalised into concepts, theories, abstractions, systematic explanations, rational reasoning, and justification of the facts. What they are involved with cannot be done by people who do not have similar knowledge and training. Their education involves a system of beliefs, such as the relation of cause to effect, which are considered scientific. Because of specialised education and training, scientists cannot be replaced as easily as non-technical worker. In one scientist's words: "We are not task oriented. We are concept oriented. It comes from a different frame of thinking. If you put a scientist in a non-scientist position and vice versa, it will take the scientist less time to learn non-scientist's stuff than vice versa. But both would be unhapply."

High income turned out to be the next major dividing line between scientists and non-technical workers. Scientists felt that they are paid better than non-technical workers because of their higher education, technical skills, and experience. According to them, scientists do not have and do not need trade unions as do non-technical workers to negotiate their salary and other benefits. Still, scientists' pay is high. The average yearly income of scientists whom I interviewed was $ 70,000. Non-technical workers' income does not compare with such a high figure. Instead of trade unions, scientists belong to professional associations that are primarily involved in the promulgation of scientific knowledge.

The majority of scientists held that they make choices about what to do and how to do it as opposed to non-technical workers. Scientists work is defined by their credentials and training, and is not dictated by managers. The kind of research scientists do is esoteric, complex, and discretionary in character. Managers have no other choice than to allow autonomy to scientists. Managers exercise indirect control by approving scientists' research. But they ascribe to scientists latitude in judgment.

Scientists even pointed out that the motivation to work differs between scientists and non-technical workers. Scientists work for the company, but they also work for themselves and gain much more intrinsic or ego satisfaction from their research. Conversely, non-techical workers "work for their hours. They do the job, make money, and go home. If they work extra hours, they are paid overtime. There is not much link between their work at home and work in the company...Scientists work towards something other than paychecks. They work more than the 40 hours a week knowing that they are not paid for extra hours. They come early, leave late, and take their work home. What they do at home is related to what they do at work." Scientists give all this time because their work is more important than leisure, and their labour is creative.

Scientists also pointed out that they differ from other professionals, namely, managers. Corporate laboratories tend to de-emphasise the distinction between managers and scientists. There is no glass ceiling for scientists and they can choose the managerial ladder. However, scientists believe that managers are technical people who do not share a collegial relationship with the scientists. All scientists interviewed had managers who have training and experience in working as scientists before they undertook managerial responsibilities. But scientists believed that the moment scientists become managers they are 'another breed'. They start 'judging' scientists instead of managing research. According to scientists, managers lose the perspective of the scientist. Managers differ from scientists over what goals research should pursue, how the choice should be made, whether direction for research should change, and what projects should be dropped.

Interviews show that scientists are not looking to cultivate either a middle or working class identity; rather, they are trying to recast themselves as an autonomous/linkage hybrid. They engage in a variety of orientations toward their changing workplace and job definition that serve, in turn, to mitigate the friction between the autonomous and linkage models as sources of identity and status, and as alterations in the way scientific research is carried out.

Objectivism and Subjectivism

The interviews with industrial scientists show two interesting trends: (i) objectively, an erosion of the scientists' position in terms of status, prestige, and autonomy, with the implementation of the linkage model; and (ii) subjectively, a struggle on the part of scientists to maintain their 'career capital' *vis-a-vis* non-technical workers. I attempt to

Table: Class Status of Scientists

Capitalists	Workers	Professionals/Scientists
Real ownership of the means of production	Legal ownership of the means of production	Legal ownership of the means of production
Appropriate the surplus value of workers	Receive wages	Receive wages
Non-labourer of products	Actual labourer of products	Mental labourer of products
Supervision function	Production function	Production and supervision functions
Exploiter	Exploited	Indirectly exploted

shed some light on this dichotomy by revisiting the Marxist class theory of professionals/scientists.

Marxists have noted that with the development of monopoly capitalism, the individual capitalist does not own the means of production. Rather, ownership is fragmented among a number of managers [Braverman 1974:259]. Further, there has been a separation between the real and legal ownership of the means of production [Carchedi 1975a]. With the development of public ownership through stocks and shares of private companies, it is the stockholders who have the legal ownership of the means of production. The real control over means of production belongs to the chief executive officer and top managers who decide what and how much to produce. Although workers may have legal ownership of the company, this does not translate into a voice in any decision-making related to production.

Like workers, scientists do not have a real economic control over the means of production. They may partake in the right of legal ownership in the company, but the shares they own, together with the scientific knowledge they possess, do not include them in production decisions. Scientists are not involved in planning for production (where, how much, the number of workers to be hired or fired), marketing, international joint business ventures, and so on. Most significantly, the successful scientists whom I interviewed did not participate in the restructuring of corporate laboratories, which is now having an adverse effect on their careers and on the direction of research. Furthermore, scientists, as sellers of their labour power, are supervised by managers (though this supervision tends to be indirect and less coercive than that experienced by non-technical workers). Although scientists enjoy a considerable degree of autonomy within the research process, final decisions regarding research projects and funding are made by managers. Scientists only propose projects and determine research designs after they have been funded. In the last analysis, it is the manager who decides what projects to undertake, the time limits on achieving desired ends, and the discontinuation of projects that fail to meet expectations.

Thus in the structure of capitalism, mirrored in the organisation of the corporate laboratory, the scientist, as wage earner and supervised employee, occupies a dependent position in the production process like non-technical workers. They have freedom in their work and enjoy better wages and working conditions than do non-technical workers, but their relative autonomy does not include them in the managers' place as the real owners of the means of production and appropriators of surplus value. These structural ties to the proletariat noted by Marxist analysts are supported by the actual, alienating experiences of the scientists in the work place.

For scientists today, research is determined mostly by marketability. With funding cuts to R and D, scientists find themselves working on more projects outside their particular realm of expertise. Further, they are also doing jobs once performed by lab technicians. Thus, their responsibilities to the corporation have increased and become more pronounced, while their job security has declined. Earlier, scientists created markets, values, and needs, with their expertise. Now markets and profitability are the main determinant of scientific research.

Yet, scientists do not perceive themselves as powerless non-technical workers dependent on management for their existence. The evidence produced in other studies also indicate that alienation and apathy have been the responses of scientists to even harsher conditions such as unemployment, as opposed to increased union activity and radicalism. Kaufman (1982) found that professionals' expectations are high, identities are invested deeply in their work, and though unemployment is traumatic, they are still not politicised. Leventman's (1981) study found that unemployment only heightened the antipathy of professionals toward vested organisational interests. It did not increase working class consciousness.

Non-technical workers in industry also maintain a 'boundary' with professionals. The major labour organisations in the US have continued to focus on manual labour, with the major exception of professionals in public sector [Melksins and Smith 1993]. Recent increases in unionisation rates among professionals are almost entirely caused by the rise in government organisations [Levitan and Gallo 1989]. Industrial scientists in corporate laboratories have no direct contact with manual workers and have not been the object of much organising by the labour organisations.

Marxist analysts have observed that a division of labour between manual and mental work has been extended into the worker's end of the production process. A final product is the outcome of a complex division of labour in which many workers participate on a variety of different levels. Carchedi (1975a) uses the term 'collective workers' as a substitute for the traditional Marxist concept of a working class to describe these changes within the organisation of the proletariat.

This category of 'collective workers' provides scientists with a place in the non-owner side of the production process. Scientists perform research for the company to develop a new product or process, or to improve an existing product or process. They are involved in the mental work of production by virtue of their higher education and technical skills. Management ascribes to scientists latitude in judgment because they possess specialised knowledge and skills. Managers cannot rely on non-technical workers as a substitute for scientists. They are dependent on scientists' expertise for creating new products or processes and improving the old ones. Scientists exercise authority through the knowledge they possess. This contributes to scientists' higher status in the organisation.

On the mental side of collective work, scientists also perform supervisory and managerial functions within the laboratory setting. These functions emerge not as an extension of the structural division of labour between managers and workers; rather, the responsibilities of scientists to design, co-ordinate, plan, organise, and supervise research projects, are consequences of the openness of research. They do not exercise the managerial authority to hire and fire, or survey and rate, non-technical workers. The supervisory role of scientists is a by-product of the way research is organised in industry. Their task is to enhance the co-operative nature of research. By contrast, managers perform supervisory roles as part of the complex division of labour. Their task is to maintain the existing arrangement between labour and the company, and to maximise the production of surplus value. Scientists do not belong to the class of exploiters in the Marxist sense because they do not appropriate unpaid labour in the form of surplus value, which is produced by the workers. Still the supervisory functions necessitated by the creative side of scientific research make scientists' work similar to the managerial side. Scientists form alliances with managers not only because they are dependent upon them for funds, but also because they believe that their goals are intrinsically linked and they can solve their problems by joining forces with managers [Latour 1987]. Furthermore, scientists are given a choice between the managerial ladder of increasing authority and the technical ladder of increasing status. They can choose the managerial ladder to be promoted to managerial positions. Scientists, therefore, have closer ties to management.

Scientists exhibit characteristics of both dependence and elitism. Scientists as non-owners of the means of production, wage earners, and supervised employees, occupy a dependent position in the workplace. These are sources of their alienation following the restructuring of corporate laboratories. Conversely, scientists as mental producers and supervisors of research, occupy a privileged position in the industrial setting. These are sources of their elitism. Scientists can, therefore, offer detailed descriptions of their dependent condition, while protesting

an identification with non-technical workers without any sense of self-contradiction.

Nonetheless, interviews with scientists do point to the limits of class-based analysis. They draw a line between power as an attribute of the ownership of capital and the power associated with privilege. Scientists exhibit no desire to become members of a particular class. What they seek, instead, is a return to privilege, predicated on scientific knowledge. Thus, there is little support for the formation of 'professional-managerial class' [Ehrenreich and Ehrenreich 1977], the 'New Working Class' [Gorz 1980], or the 'New Class' [Gouldner 1979]. The friction due to the changes in the corporate laboratory from a science-driven to a market-driven mode of production, does not produce a new class consciousness among scientists; but, a new complex of social relations and identities. This is perhaps a sign of the usefulness of Weber's idea of society as composed of social relations.

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