W. P.: 408

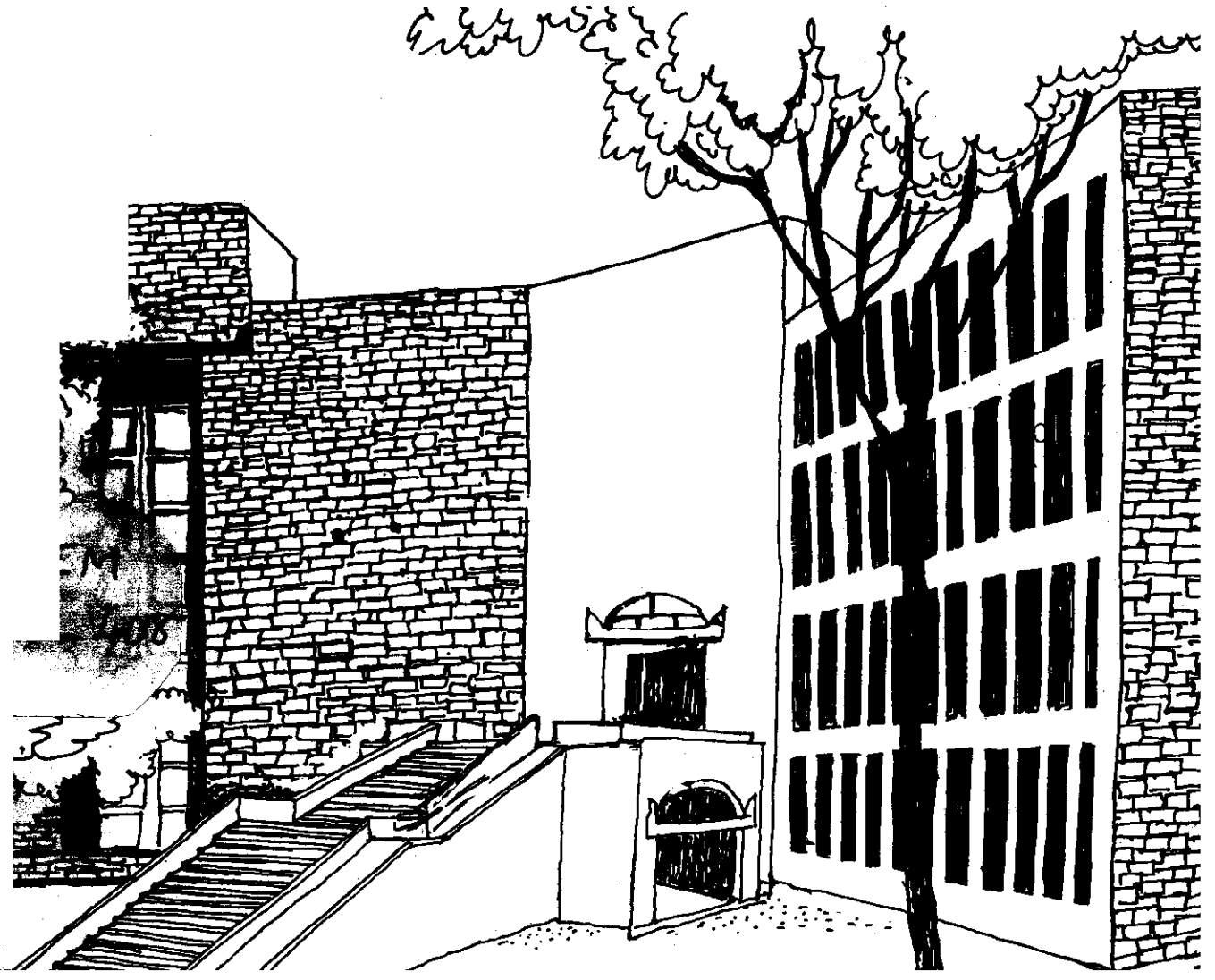
Working Paper

By

T.K. Moulik

&

R.K. Gupta

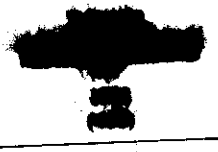


By

T.K. Moulik

&

R.K. Gupta



W P No. 408

January 1982

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380015
INDIA

Choice of Technology: Some Forethoughts on a Socio-Technical Approach*

Dr. T.K. Moulik & R.K. Gupta
Indian Institute of Management, Ahmedabad

Irving Louis Horowitz wrote more than a decade ago that "with remarkable consistency, early pioneers of sociology believed that engineering, as a practical art and an applied technique, offered the best supportive model of any meaningful science of society. It would seem that the situation has now become reversed."[1] But recently, William Fottee Whyte lamented in almost a confessional way that the social scientist on facing this challenge suddenly found himself without sufficient conceptual or analytical tools.[2] Whyte wrote further that "the reformulation of social theory ... requires us to examine the conditions for realization of these (humanistic) values by concentrating upon the structural elements influencing human behaviour. This means working at the social system first in terms of technology, work flow, division of labour, structuring of work activities and the system of reward and penalties (both economic and non-economic)"[3]

---

*An earlier version of this paper was presented and discussed at the United Nations Research Institute for Social Development, Geneva on May 22, 1979.

Irving Louis Horowitz, "Engineering and Sociological perspectives on development:interdisciplinary constraints in social forecasting", International Social Science Journal, Vol. XXI, No.4, 1969.

William Foote Whyte, Organizing for Agricultural Development: Human Aspects in the Utilization of Science and Technology, Transaction Books, N.J., 1975.

William Foote Whyte, op.cit.

With these comments I confront both the technologists and the applied social scientists to look at the problem of technological advancement afresh. An immediate collaboration between the two streams of knowledge may be the most appropriate first step in this direction but that wouldn't be enough. We will have to transcend the disciplinary boundaries to gain a fresh look at our reality and do something about it. In the following, We will present our own conceptual attempt in this direction in the form of a socio-technial approah elaborating some of the aspects of this approach which seem to have direct relevance for the question of choice of technology.

Socio-technicalApproach

We so far, find it impossible to conceive of reality out of the space-time continuum, i.e., We as average human beings, cannot think of an "event" which does not crave for a space-time reference. This limitation of our comprehension indicates to us that all events are embedded in space-time continuum. This is the material aspect of reality. In an epistemological effort, the acceptance of the material nature of all phenomena is an attempt to grasp the existence, continunance and movement of matter. This materi l image of reality has been the basic framework for understanding 'objective' reality in natural sciences and their application in the form of technology. In this frame,, the criteria of choice also have concomitantly been material. This material conception of reality has also been the basis for major contents of life science where the corporeal nature of plants, animals and human beings has been studied to a great advantage.

But, we have not yet explicitly stated the necessary presence of at least one human being ("the primal inquirer" ;) even to conceive of space-time framework. We do so now and discover that allspace-time coordinates do not 'mean' the same to us. We seem to have an evaluative consciousness which attaches meaning to matter. And there are so many more human beings like us whose contents of concsciousness are not necessarily the same as ours. The understanding of cross-cultural phenomena indicates that one object in the space-time continuum can 'mean' different things to different individuals. That is to say that a pure material object can have more than one meaning in the multi-individual situation; or to say it in mathematical set-theoretic language, the mapping from objects to meanings is not one to one. As a special category of this general statement some objects which have a meaning in one context need not have any in another, for example, that corner which to me is empty may mean a highly polluted space for anextremely scology-conscious person.

There is another dimension to a multi-individual situation. This relates to the presence of 'other' individuals in the context of each of them. Human collectivities exhibit properties which maks special effects on the statics and dynamics of the situation. For exampls, two human groups in the same space-time location may behave differently because one has cohasiveness while the other does not. Add to this variability the dimension of 'meaning' stated above and we have another complex mapping between the paychological and the material aspects of reality.

Mapping at the symbolic level in the cultural and psycho-dynamic sense is just an extension of the conscious level of meaning. At the cultural level, it is likely to manifest in form of norms, beliefs and values.

In summary, what we have said above, is that reality which consciousness comprehends in space-time continuum has two sets of values; one at the material level and the other at the meaning level. The mapping between the two sets appears to be a complex function which is still far from the complete grasp of scientist-human-beings. The socio-technical approach accepts this two-set postulation of reality and makes the grasping of the function relating the two-sets as a major objective of human understanding.[4] This approach is also likely to give greater concrete results. In brief, such an understanding aims at the "joint optimization" of technological and social systems in their outputs at the material and the meaning levels. Extremely promising results have been reported from industrial settings in industrially advanced nations.[5]

Material conditions and meaning consciousness

The idea of meaning level of human reality is very close to the idea of human consciousness and we feel that Marx had highlighted a very important aspect of the socio-technical interactive reality when he emphatically said that "Life is not determined by consciousness, but consciousness by life."[6] We feel no urge to arouse the controversy between the materialists and idealists afresh because to us the controversy itself exists only at the level of polemics. We see no problem in admitting a small minority of human beings whose consciousness extends beyond their material condition

[4] Political, economic or aesthetic aspects of the human reality are special interpretations at the meaning level. They are thus integral aspects of the sociotechnical perspective.

[5] Fred Emery and others, The Emergence of a new paradigm of work, Centre for Continuing Education, Australian National University, Canberra, 1978.

[6] German ideology.

(we believe we are two of them!) and it is always worthy of hope and efforts to increase the number of this minority (isn't it that what we are trying by writing this paper!), but nor do we feel any hesitation in saying that for a overwhelmingly large number of human beings Marx's contention is an empirical reality. Even the existential cry of our time that "existence precedes essence"[7] can be seen in this light as a cry to wake up this multitude to realize how inadvertently they succumb to the implicit essence of their existent material reality. They must become aware of this seduction and reinvent their essence transcending and transforming their immediate socio-technical reality.

Elaborating further on the theme of consciousness, Marx has written that"... this is not an original, 'purs' consciousness. From the outset, 'spirit' is cursed with the 'burden' of matter .... Consciousness is at first, of course, merely an awareness of the immediate sensible environment and of the limited connection with other persons and things outside the individual who is becoming self-conscious. At the same time, it is a consciousness of Nature, which first appears to men as completely alien, all powerful and unassailable force... This sheep-like or tribal consciousness receives its further development and extension through increased productivity, the multiplication of needs..."[8]

Process of Change

Marx saw technology as "the process of production by which he (man) sustains his life, and by which also his social relations, and the mental conceptions that flow from them, are formed."[9] But Marx's understanding of the interaction

[7] Jean-Paul Sartre, What is Existentialism? Reporoduced in Titus and Hepp (eds.), The Range of Philosophy (2nd ed.), Affiliated East-West Press, New Delhi.
[8] German ideology.
[9] Capital, Vol. 1.

between technology and social order also led him to state that "No social order ever disappears before all the productive forces for which there is room in it have been developed; and new, higher relations of production never appear before the material conditions of their existence have matured in the womb of the old society.[10]

If we are allowed to extend Marx's concept of 'relations of production' to include the social-psychological aspects in addition to the usually understood socio-economic aspects, we see the major challenge as well as at least one way of getting over the problem of changing material conditions of human living. The challenge lies in confronting Marx in his diffidence about changing "before the material conditions have matured in the womb" and a way out lies in squeezing and accelerating the maturation of existing material conditions over time paving a way for a transformation into a new social order.

Such an endeavour requires a conceptual and analytical understanding of technology in its relation to human consciousness. If the technological progress comes as a natural evolution of the consciousness as perhaps it did in the nations which went through the complete grind of industrial revolution, this caution does not find a chance to raise its head but when our attempt is to accelerate the advancement of technological consciousness from pre-industrial material conditions directly to an aspired "post-industrial" utopia we will have to confront this issue head-on. We will have to explicitize the concurrent demands on human consciousness as

[10] Preface to A contribution to the critique of political economy.

the technological advancement takes place, for then, we can attempt our task of facilitating and accelerating our ideal of rapid technological advancement from a pre-industrial to a post-industrial era. Below, we attempt such an explicitization in brief which, if found appealing, would require empirical verification and experimental application to form a sound basis for technological analysis in a socio-technical framework of societal goals.

A theory of sociotechnical development

In this section, we will present a set of interlinked propositions which connect 'scientific-technological' and the 'human consciousness' aspects in the process of sociotechnical development.

Our first proposition is a normative proposition about development. It states:

1. The goal of development is the achievement of human satisfaction, both in existent and aspirational terms.

The next proposition is a materialistic view of such development, moderated by value choices. We state:

2. Human satisfaction lies in producing and enjoying the desired products in desired quantities.

The above is a statement at the aspirational level of human satisfaction, while

3. Actual production of desired products is determined by the perceived limits to the possible productive activities.

These perceived limits we equate with a belief system about techniques of production. Putting it as a descriptive proposition, we state:

4. Limits to the possible (regarding technique of production) define the belief system regarding productive activities.

And so,

5. Any extension of the perceived limits to productive activities amounts to changing a belief system.

Within the boundary of this belief system, we propose that all human beings are equally rational. By this, we mean to state two things: one, the distinction between the pre-industrial and industrial societies on the basis of intellectual attributes is baseless; and two, that distinction should instead be made on the basis of the boundaries of such belief systems. To make the point clearer, we would like to mention a particular boundary of scientific belief which exists even in the most advanced nations. It is the insistence of science on observability. This particular belief has led to a mystification and rejection of techniques of spiritual development at least so far as recognized scientific endeavours in these countries are concerned. To us, it is exactly the same when a villager rejects the possibility of transforming heat into mechanical power, or accepting a helicopter as a human phenomenon.

By admitting equal rationality within the boundaries of the belief system, we are equating the basic logical processes of human mind all over the world. Within these boundaries, all the people of the world can be seen as working on inductive and deductive logical systems. That is to say that

6. All productive activity of all human beings is based on a logical understanding and manipulation of reality.

And so,

7. Any change in productive activity is based on a logical understanding of the production process.

But,

8. A change in productive activity presupposes some change in the existing belief system about the limits to the possible and this belief system can have different nature of openness or closeness for the change.

To elaborate, let us look at the basic urge to explain in the rational human being. For any phenomenon, if one explanation already exists, a new explanation has to demolish the old one. But if the explanation of that phenomenon exists in the form of a boundary relief, given the nature of beliefs, it would be extremely difficult of being displaced by logic. This is where there is a distinction between the pure inductive logical explanations and deductive logical explanations, and we propose that

9. Within the boundaries of the belief system about productive activities, a change in productive activity would be humanly acceptable through inductive logical understanding, but outside the boundary only inductive understanding is likely to lead to a mystification of the new productive activity.

But,

10. The boundary of such a belief system is likely to be extended if it is done by extending the chains of deduction that already exist within the system.

We will take a hypothetical example to illustrate the proposition. Let us imagine a society where a simple lever principle is used to obtain a mechanical advantage. But they are naturally limited by the best available straight bars of wood which have a limit to their tensile strength. These two facts would govern the perceived limit to the possibility of achieving mechanical advantage. Now suppose we go with an all covered up device (a black box in scientific parlance!) and demonstrate a mechanical advantage greater than this limit. We can do this demonstration again and again. It is a kind of inductive approach to increasing technological understanding of the 'primitives'. We are sure the black box is more likely to be seen as a supernatural miracle.

Then, we reveal the contents of the 'black box' showing the same level principle even if with a stronger metal rod. We can imagine a sense of relief and amusement on the faces of the 'primitives'. The limits of the possible have been extended in that moment, though some mystification is left to be taken care of in the form of the new rod.

There is another dimension to the extension of productive activity. This relates to the form and the function of such an extension. In the socio-technical sense these two are the material and the meaning levels of the extension. Any extension then can either be an extension in form only or only in function or in both. Each of the three cases of change is likely to be reacted to differently.

11. A change in the form of the technique without a change in the function is very likely to become a stable change through inductive understanding.

But,.

12. A change in the function (new for the people) without a change in the form is likely to be abandoned unless the new function formed a part of the aspirational level of human satisfaction.

And,

13. A change in both the form and the function would be most difficult of acceptance. Only if the new function is a part of the aspirational level can we hope to succeed.

Actually, there can also be a pure quantitative change when neither the form nor the function of an innovation change. In that case,

14. The change is likely to be easiest when there is only a quantitative extension without a change in the form or function.

An excellent example of such a case is the tremendous success of high yielding varieties of seeds in agriculture. Neither the form nor the function of seeds had changed in any immediately significant way. Introduction of pneumatic tyres in camel-carts in Rajasthan is a similar example.

An example of change in form but not in function is the gober-gas plants which were initially difficult of acceptance for religious/hygienic meanings attached to it but were later accepted for the function they performed. A possibility of their rejection arose because of the disruption of time structuring etc. Another example of change in form without explicit change in function is a simple tractor for ploughing. Sometimes, it is likely that the new functions may not be explored at all. The engine of a tractor though possible of other functions may not be used at all for those functions.

An unmystified technological advancement can take place only through logical extension of the existent belief system about the possible productive activities. And, as stated above, it has nothing to do with greater or lesser sophistication of the technology. The crux of the materials analysis and matching of the existing logical systems of the people and the new scientific logic.

Socio-psychological factors in socio-technical analysis of technological systems

Under this section, we wish to reiterate the work and findings of various people who work at the Tavistock Institute of Human Relations in London. Major spokesmen of this work have been Fred Emery, Eric Trist, P.G. Herbst, and Thorsrud.[11] We would not be labour to repeat their principles, analysis and design approaches they have applied in various industrial settings. Their contribution lies in experimenting with ways and means of the design of technological systems achieving a joint-optimization of social and technological systems. They have proved the feasibility of designing alternate social systems for same technology and developing alternate technological systems for same tasks. They have demonstrated the possibilities of increasing the psychological satisfaction of the individuals through socio-technical work-redesign and increasing social collaboration and homonomy through designing work systems around the concept of autonomous group functioning. They see the possibility of achieving a kind of industrial democracy at the worker level. These ideas deserve special

[11] See Fred Emery (ed.), The Emergence of a New Paradigm of Work;
P.G. Herbst, Socio-technical Design;
Fred Emery and Einar Thorsrud, Form and Content of Industrial Democracy.

attention for the choice of technology for societal development in a socio-psychologically harmonious way aiming at the 'concrete relations of production'.

Socio-economic factors in socio-technical analysis of technology

The main factors in this category are (a) the quantum of immediate vs. long term economic benefits, (b) the spread of such benefits, (c) the structural distribution of these benefits in terms of classes in the society. Elaborate analyses of these factors have been made by economists and useful insights obtained. But such analyses failed to be implemented or failed in the process of implementation because of insufficient understanding of the micro-level details of technological advancement both at the psychological-consciousness level and the socio-psychological group-dynamics level. There is a great need for improving upon these shortcomings before these elaborate macro-economic analyses and criteria can be operationalized for technological advancement and equitable distribution of the fruits of the technological advancement.

Concluding Thought: Supremacy of the method for praxis

We have picked the above subtitle from a chapter heading of John Dewey's "Quest for Certainty". The underlying message has crucial implications for making a headway in overcoming the schism between the technological understanding, research and applied social research, because this schism is the backdrop of any human problem interfacing the social and technological objectives.

Scientific and technological progress is easily seen as the triumph of its experimental method for increasing the understanding of nature and validation of the application of such knowledge to arrive at technological solutions to human problems and aspirations. But somewhere in the quest of social-scientific knowledge which can eventually sugment the scientific-technological achievements, man shrunk from his own guilt of experimenting with human beings.

No doubt, more serious ethical responsibility is involved in social experiments but that is the proven way in advancing theory and practice. Nor are we in any real way ridding ourselves of the guilt of manipulation in insisting on finding the best solutions even under the conditions of imperfect knowledge. Russell Ackoff has summed up the position as follows:

> "In the democratic societies with which I am familiar, there is almost an innate abhorrence of social and economic experimentation. We think it demeans the subjects and threatens with the possibility of excessive public control of private lives yet, curiously enough, no other type of society manipulates and varies the form and content of its control over its members as much as a democratic one. Democratic nations constantly change taxes, tariffs, interest rates, zoning rules, laws, regulations, transportation and communication systems, metrics and even the clock. The major aspects of experimentation-manipulation and control - are already widely practised in such societies. They even attempt to measure the effects of changes in public policy on national performance. But here is the rub: they usually do not let the design of the evaluative procedures affect the way the public is controlled or manipulated. The evaluators are called in <u>after the fact</u>, when it is too late to do an adequate job of evaluation and when possibilities of gaining understanding are almost completely destroyed."12

Under imperfect knowledge along with the choice of technology it is the onus of applied scientists to carry the guilt of their inability to know the best choice and work with more than one appealing choices and rapidly learn from such experiments. In the process they would improve their capability to make better <u>choices in</u> future.

[12] Russell Ackoff, "Operational Research and National Science Policy" in de Reuck, A (ed), <u>Decision-Making in National Science Policy</u>, London, Churchill.