A PROFESION CONFRONTS ITS FUTURE

FE EMERY, SEPT 1977

> "The engineers… were in nine cases out of ten, conservative in politics, acceptance of any regime in which they found themselves, interested in making their machine work, *indifferent to the long-term social guesses*." (C.P. Snow, *The New Men*. My Italics).

Today's conference rather dates C.P. Snow's observations about engineers or at least shows that the consulting engineers are the exceptional, one-in-ten.

There are good reasons for consulting engineers to consider the shape that organizations may take in the future. Organizational design is in a ferment and the outcomes are concern to consulting engineers:

1. It concerns the way they will organize themselves to provide their professional services.
2. It concerns the manner in which these services will need to be provided if they are to be acceptable.
3. It concerns the content of the services they will be called upon to supply.

We shall see, I hope, how much these are real concerns and pressing concerns.

To assemble the evidence I will need to do, in brief, what you are doing in the whole conference i.e. to go back in time. Only in this way can we hope to pick up what there is in the present that is likely to a dominant feature of our future.

Of the three concerns I have specified I will consider the last one first – the concern about the content of your advice.

Ever since there has been an identifiable role for an engineer they have been up to their necks in advising on the best ways to organize men, machines and money to get jobs done.

Their professional function is to design machines and plant, and then to advise on how these can be created and used by human beings to the best advantage for human beings or some human organizations.

In practice they have always been a "profession without community". They have accepted the values placed on human beings and the value placed on money that their clients or masters have dictated. The other great professions, including the oldest, have always sought to define 'best' in conjunction with a community. I am not for one moment suggesting that these other professions always acted in accord with these community understandings. I am suggesting that engineering as a profession never felt it necessary to pay too much attention to the community as distinct from the client. That again is not to ignore the fact that some engineers held fast to the notion that the best way of bringing together machines, materials, men and money had to be geared to community standards.

What I am stating is that the profession that set itself to design tools and structures and advise on the best ways to use these has historically accepted that their own role in society should be to offer themselves as tools.

I am well aware that this is a harsh introduction to our topic but I am reflecting on the same facts that led Perrucci and Gerstl to entitle their classic study of recruitment into the engineering profession in the USA the "Profession without community".

If one turns to the history of the engineering profession one gets the same message.

So what does this mean? My task is to explore the future forms of organizational structure: others in this conference have dealt with the history of the profession so why do I not leave that well alone and get on with contracted task?

There is one good reason why I will not let the past alone. The shape of our near future, ten to thirty years, is almost certainly existing here today in embryo. It is also pretty certain that those processes of current change that will shape our future are barely recognizable to us because they have gained acceptance (and resources) by masquerading as solutions to our old problems. I will give but two examples, and admit that these are open to challenge as in both cases we have not seen the end of the processes they have set under way. Freeways were going to give a new lease of life to the Central Business Districts by better tying together these areas with the commuter suburbs. Instead we find a recolonization of the inner working class suburbs and a growing drain from city population. Television was going to supplement the higher levels of formal education with an immediate, up-to-date, see-it-for yourself information service which would create a transformed electorate. So far it has simply dried up the support for hard information sources and turned elections into popularity contests.

In both of these cases we invested massive resources because they were sure-fire solutions to our old problems. In both cases we have created an infra-structure that propels us to a future we did not seek.

The two examples I have given could hardly be regarded as trivial examples of how in our recent past we have shaped our future. However, I do not think that they can compare with the significance of the new forms of organization that have been emerging over the last fifteen years.

The principles by which we recognize ourselves determine how we engage in production, in governing ourselves and how we run our community, family and private affairs. We are inclined by our recent past to think of these principles in terms of aristocracies, plutocracies, dictatorships, democracies, bureaucracies, meritocracies or anarchies. I suggest that we are confronting just two basic principles of organizational design. Organizational designs that do not conform to one or other of these designs are not viable designs.

This underlying simplicity has a great deal to do with our ability to forecast ‘the organizational structures of society in the next ten to fifteen years’.

Forecasting is in any instance a dicey matter but we are generally better able to forecast when we deal with the broader, more global social processes than with the narrower, more specific ones. Thus for instance we would expect to be able to make more firmly grounded predictions about the GNP in ten to fifteen years than about the output level of the Australian carpet industry. Furthermore, we are usually better able to predict the course of a newly emergent social process after it has been growing for a decade or two than we can just a couple of years after it has been noticed (Emery, 1968).

In looking at organizational developments as primarily determined by the relative fates of just two basic design principles we gain a very broad perspective and, as I will show later, the shift in their relative potency dates back at least fifteen years. Both features act to give us a chance to see where we are going.

Now let me try to explain why these complicated matters can be reduced to a choice of two designs and what are the distinctive features of these designs. Only after that will I try to spell out what the future holds for us if, as I maintain, the second design is replacing the first.

In choosing their organizational designs people do not confront an infinite range of choice. Far from it. If their organizations are to be purposive they have to be adaptive over a wide range of evolving circumstances. The alternative is some sort of servo-mechanism with a fix repertoire of responses and capable of surviving only within a very narrow range of foreseeable conditions. To achieve this adaptiveness redundancy has to be built into the system. This is an important property as with each arithmetic increase in redundancy the reliability of the system tends to increase exponentially (Pierce, 1974).

There are two basic ways that redundancy can be built in;

(a) by adding redundant parts to the system; each part is replaceable; as and when one part fails another takes over;

(b) by adding redundant functions to the parts; at any one time some of the functions of any part will be redundant to the role it is playing at the time; as and when a part fails in the function it is performing, other parts can assume the function; so long as a part retains any of its functional capabilities (i.e. functional relative to system requirements) it is of some value to the system.

The first design of redundant parts has been described by Mumford as the Megamachine and he has traced its long Asian history and more recent Western debut (Mumford, 1967). Feibleman and Friend characterized the logical properties of the first design as *Subjective seriality*, in which "The governing relation is *asymmetrical* dependence. The sharing of parts is necessary to one of the parts but not to both." (1945, p.36). The second design is characterized by them as Complementary seriality, in which "The governing relations is *symmetrical* dependence. The sharing of parts is necessary to both of the parts. Neither part can survive separation" (p.36). "… parts are on a parity with respect to their relations with other parts, and each is dependent upon the other" (p.38). It is of interest that their analysis of "The structure and function of organization" revealed no more than just these two basic designs at the level of purposeful systems.

If redundancy is sought by having redundant parts then there must be special control mechanisms (specialized parts) to determine which parts are failing and have to be rendered redundant, and which have to be activated for any particular response to be adaptive. If the control is to be reliable it too must have redundant parts and hence the question of a yet further control emerges. The more difficult it becomes to determine the failure of dependent parts in time to make adaptive replacements the more the levels of control tend to proliferate (compare the many levels of control to be found in an army or an oil refinery with the few that are found necessary in a car assembly plant).

One can expect a bias toward choosing the first design if (a) the cost of the individual parts is cheap and (b) there are long lead times available for the organization to learn new modes of response. Certainly, once this first basic design is chosen efforts will be made to keep down the cost of the individual part by sustaining a pool of unemployed, obtaining access to pools of poor and preferably dispossessed peasantry (e.g. the *gustarbeitet* of Germany and Australia's post-war migration scheme), or specializing the

function of the individual parts to minimize costs of training and re-training (Taylor, 1911).

Regarding the second source of bias toward the megamachine, long lead times, it is worth starting our considerations from the oft-made observation that this is a great way to run a railway or an army:

> "There are irrefutable advantages to this kind of organization. Discipline is good, errors in routine procedures rarely go unchecked, and if the very top man is an exceedingly able executive he can usually make the whole organization jump to his command very quickly. It usually takes a long time to build , and it is at its most successful when the function of the organization is to control a very large number of people all doing more or less the same thing. It is the way most armies are organized – platoon, company, battalion, brigade, division, corps, army – and if you want to make a million men advance or retreat at a few hours notice it is hard to think of a better system." (Jay, 1967, p.73).

Armies fight for short periods of their life under conditions of great uncertainty, great turbulence. Hence it is hard to reconcile Jay's enthusiasm for organizing armies in this way with our contention that they are only adaptive when allowed 'long lead times for learning.' It is also hard to reconcile with the organizational logic that underlies our contention, namely that *this type of system is inherently error-amplifying*. The governing principle of asymmetrical dependence means that errors will leak in form the environment like water from a sieve; it is in no one's interest to have himself rendered redundant because an error, or failure, can be associated with him. Even without that psychological weakness the relation of asymmetrical dependence will ensure that the flow upwards of information from one level of control to the next will take the form of $T= (1-F)^n$. If a manager had five good people reporting to him, people who were truthful (T) eight times out of ten, i.e. $T = (1.0-0.2)^5$, then there would be, an average, only one in three occasions that he could say to himself that this must be pretty true because they are unanimous. However, the same principle applies at all levels. If he and four others at the same level as himself have been well chosen, and hence are right nine times out of ten, then the chances of their superior getting such a good straight message coming up from the work-face are, on the same arithmetic, 0.002, twice in a thousand such communications! (Stafford Beer 1972). This very disturbing property of error-amplification arises in a system based on asymmetrical dependence of his subordinates on him. Hence he will seek to ensure that each of his subordinates gives him their *independent* judgment and that they cannot go into collusion to influence his decision. But the mathematics of this are inexorable. The more he achieves this aims of controlling his subordinates the deeper he gets into error – even if the subordinates are not psychologically motivated to protect themselves by hiding their errors.

Given this inherent weakness a major part of the effort of utilizing cheap dependent labour by this first design has gone into control systems that will minimize the weakness. Thus Jay, in the above quote, says that in these types of organizations discipline is usually good. We suggest that in these types of organizations one usually finds good discipline, not because they naturally create good disciple, but because they cannot function without imposing firm discipline. That they cannot function unless their

individual parts are not only replaceable, but are also so threatened by punishment or withdrawal of rewards, that they will behave in a pre-programmed manner regardless of the evidence of their senses or their common-sense. Lewis Mumford has documented the vicious practices of torture and maiming that were introduced with the earliest emergence of the megamachine; poet-laureate Masefield has documented the inhuman disciplinary practices of the Royal Navy up till the age of steam. Taylor and his contemporaries simply updated this tradition so that this organizational design could function within societies like USA where the Constitution forebade "cruel and inhuman punishment." There was no change in the aim. The aim remained that of blocking the holes of the sieve, preventing error getting into the system. By elaborate pre-programming of the parts at the work face, and of the control systems, expected contingencies could be met and failure of a part quickly identified. As Jay observed, such an organization "usually takes a long time to build." Standard operating procedures, rules and regulations and training manuals have to be multiplied to meet the ever-newly emerging contingencies. They can rarely be wiped off the book because there can rarely be agreement in the control agencies that those contingencies might not to occur again. New contingencies are slow to be recognized in S.O.P's because it is never too certain whether they are inventions of subordinates trying to cover up mistakes that might lead to their redundancy.

We can now summarize the learning properties of an organizational design based on redundant parts. There is an optimal amount of error that is necessary for learning by any type of system. The error-amplifying characteristic of this type of system threatens to swamp it with so much error that it is reduced to the response strategy of an addictive gambler, or a cat in a Thorndike puzzle box i.e. stick rigidly to a system, right or wrong. The major active response to error is to prevent it getting into the system, even those errors that are necessary for learning; and to eliminate or send to limbo any part that appears to be associated with the intake of error or its perpetuation. With this sort of learning where is the adaptiveness? Jay is undoubtedly correct in stating that with this sort of system it is hard to think of better one "if you want to make a million men advance or retreat at a few hours notice." It is possible, with months of work, to pre-programme so many to start to advance or to start to retreat within hours of the starter's gun. Adaptive control more or less finishes after that point, unless has pre-programmed reserve forces to be fed into the subsequent action. Filed Marshall Haig released a vast pre-programmed army across the front of the Somme at 7.30 a.m. July 1st, 1916. At 3.00 p.m. that day he had precious little idea of where his many divisions were or what they were doing, although none of them had gone more than a mile or so from where they were at dawn. They had disappeared into the fog of war. This sort of information flow hardly augurs well for adaptability. When the Passchendaele offensive opened on July 31st, 1917 there was little evidence that learning had occurred in the previous year. As we said earlier this type of organization needs a long lead time for learning. So long, indeed, that Liddell-Hart said that armies normally prepare themselves to fight their last war.

The criterion of survival can be somewhat misleading in circumstances where the competing parties are all organized on the first design principle. The big battalions win the wars but lose the peace.

It should be clear by now that choice of the design principle of redundant parts pre-determines the ideals that such a society will pursue. Man will be set against man in the asymmetrical man-servant relation to ensure that their collectivized labour will produce *Plenty* in the form of pyramids, skyscrapers or other such indicators of the greatness of their masters. Better ways to ensure increased productivity will evolve and when evolved, be widely adopted. But increasingly people will doubt whether these means of increasing plenty are reconcilable with the quality of human life[*]. *Truth* will be a precious commodity in an environment where it decays so quickly in transmission up to the key decision makers. Every effort will be made to arrive at better ways to establish the truth and to disseminate such methods when they emerge. The good will be an ideal of high standing, as befits an ideal. Science becomes the new fountain of wisdom and becomes increasingly mistrusted in societies based on this first design principle. The concept of the 'good samaritan' evolves into the Welfare State. Good deeds are increasingly done by numbers, and the poor, deserving or not, wonder whether they are not just replaceable chippers in a code that they cannot break.

The ideal of *Beauty*, an ideal that should move all people, suffers a particularly cruel fate in systems designed on this principle. The ideal becomes embodied in that which is biggest, whitest and most durable; and capable of demolition tomorrow. The criteria of beauty, and that which attracts patronage, are grandeur and being esoteric. Both criteria place beauty beyond what might be aspired to by a mere servant in a system based on master-servant relations, i.e. subjective seriality.

It should by now be clear that this first basic design is identical with that espoused by the so-called school of scientific management and also with Weber's concept of a bureaucracy and Lewis Mumford's Mega-machine.

By the 1960's it was everywhere taken for granted that this was the only way to design an efficient production system. This was 'the one best way' regardless of whether you were designing for factory work, construction, transportation, clerical, marketing or even design work itself. Even now, in the late seventies, I would guess that ninety per cent of the organizational design proposals on your drafting boards still, unthinkingly, assume that this is the one best way.

From at least the turn of the century the engineering profession has been in the fore-front of those diffusing this concept of organization. So much so that this has often been referred to as 'the machine model of organization' and some have come to see it as the epitomization of the Weltanschaung of the Engineer.

There is, as I mentioned in the introduction, a theoretically viable alternative. Before I spell this out I want to remind you that it was not so long ago when a significant body of engineers were aware that there was this alternative basic design and that it offered some eminently practical advantages.

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[*] Footnote These three criteria for identifying an ideal are taken from Ackoff, 1949

The eighty years from when the Southport railway was started in May 1822 have been called the Age of the Navy. In that period millions of navies made 20,000 miles of railway in Britain and thousands more in Europe and the rest of the world. A very common form of this work was by the so-called butty-gangs. Groups of workers collectively sub-contracted to do a job, split the single pay-note according to their own principles, and undertook to organize and discipline themselves without any externally imposed gang-boss or foreman. This was the system that Thomas Brassey, Snr, probably the greatest of the prime contractors, swore by. It was, he maintained till his death in 1870, the best system for maintaining reasonable discipline and giving the men a personal interest in doing a decent amount of work and finishing a contract on time (Coleman, 1968, p.57).

The contrast between the two designs could hardly have been more strikingly displayed than when Brassey had his navies building a railway alongside the mega-machine of the British Army in the Crimea. For all their floggings they could not match the performance of Brassey's organization (ibid, pp 212-20)

This alternative design based on redundant functions (multi-functional parts) has been the favoured design in the western cultural tradition, if not always in practice. It also appears to have been the general preference in human societies up to the point where swidden agricultural gave way to societies based primarily on cultivation and use of metals.

The basic conditions favouring this second design are;

(a) the individual parts are costly (e.g. well educated or skilled) or highly valued;
(b) adaptation has to be to a highly variable, complexly inter-correlated environment i.e. one in which a great deal of potential error is present and it is not randomized.

In contrast to the first design this one is essentially error attenuating. The system by its own functioning tends to suppress error that comes into the system. The formula given by Beer is $T = (1\text{-}F^n)$. Thus if, as in the first example, a manager has five people reporting times out of ten then $T = (1.0 – (0.2)^5)$. Only about three times in 10,000 will they unanimously give him the wrong advice. The relation of symmetrical dependence means that they will check with each other as to the quality of the advice they were thinking of giving. We have assumed that they are no better as individual managers than those in the first example, and no better than each other. Each is assumed fallible in two occasions out of ten. They will not, however, be fallible in the same ways, and hence working to this second design they assist to suppress each others tendency to err.

With this quality a great deal of error can be accepted into the system and learnt from. Rigid barriers of standing operating procedures and manuals do not have to be defensively manned as in the first design. Error is coped with by continuous learning and rearrangement of functions; not by prescription and rearrangement of parts. In this system advantage can be taken of the principle, the total sum of error in the system is equivalent to the square root of the sum of the square of the errors of each part. Attention can be directed to the weakest link, as this principle requires, and not to the specialized controlling parts as required in the first system. A further distinction between the two

designs arises when the sources of error in the environment are to some extent correlated i.e. 'it never rains but it pours.' The first design is at its best when the sources of error are independent, and only randomly occur together. Where this is not naturally the case special efforts are devoted to approximate this condition e.g. keeping external relations in special compartments, and being very secretive about what is going on in those compartments. The second design learns better to adapt by exposing itself to the difficulties that arise for itself from these external inter-dependencies.

A striking difference between the two systems occurs in the switching mechanisms. In the first design the critical decision is switching some parts to redundancy and activating others. The individual parts are probably not keen to be rendered redundant and not even very enthusiastic about being activated. These decisions are for the special control parts, and it is pretty irrelevant to their function whether the parts know why they are switched. In fact, anything that psychological separates the special control parts off from the others would help to ensure that proper decision rules are followed, and are not obfuscated by mere human consideration. In the second design, with its governing principle of symmetrical dependency, the switching is governed by the conditions of mutual help. The problem is that all parts (enough parts) need to be alert and willing to bring their unused capabilities into action when the shared task demands it. Without considerable sharing of values and objectives, the potential of this design may not be realized, which may be one reason why Taylor turned to re-vamping the first design for the utilization of the multi-national work force pouring into US industry in his days.

One other property of these systems was noted by Feibleman and Friend, and been frequently observed. Organizations based on redundancy of parts constantly strive to accumulate a superfluity of parts; to ensure that at any one time they have more parts than they actually need for what they are doing. These reserves of duplicated parts are essential to ordinary day-to-day operation, and the major insurance against the unexpected. This superfluity of manning is sought at all levels except the very top. By contrast organizations based on redundancy of functions (capabilities) find their optimal level at a point where undermanning stretches their joint resources, and challenges them to frequently reallocate functions[*]

These are important distinguishing characteristics of the two design principles but the crux of the difference lies in the fundamental organizing principle that enables each to be a *unitas multi-plex*, an organized whole with differentiated parts. The difference emerges right at the very point where power and responsibility are allocated to get the work done.

In the first design the fundamental unit, the building block, is the squad, under the supervision of the gang boss (Mumford p 192).

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[*] Footnote. In *Logic of the living brain*, 1972, Sommerhoff tried to identify models that would explain the uniquely adaptive characteristics of that organ, and still do justice to the knowledge we have of its structure and functioning. He was led to reject the design based on redundant parts and to postulate two variants based on redundant functions. These two variants closely parallel the discussed by Emery and Emery (1973)

In the second design the fundamental building block is the self-managing group working to freely agreed objectives.

To some minds this might seem too trivial a distinction on which to distinguish two basic design principles. I will for the moment simply suggest that the distinction between a servant and a man (or woman) is as fundamental in terms of social system design as the distinction between hydrocarbons and hydroflourides for technical system design.

As far as we can see the two design principles cannot happily persist together in the same organization. If the work to be done is organized according to one principle then severe pressures develop to ensure that the planning of that work is done in accord with the same principles and likewise for the formulation of organizational objectives and values. More than that, a consulting body that espouses one set of design criteria soon finds itself constrained to do with itself what it counsels others to do.

The differences between the two designs are so profound, and have such wide ramifications that I think that in choosing for the second design people are implicitly choosing for a different and improved quality of life. Whatever the immediate pay-offs in terms of extra money for multiple skills and productivity they are usually quite sensitive that more is at stake. For the employees it is the prospect of getting a life-long monkey off their backs; for the employers and their managers it is the chance to stop riding others and get on with what they are professionally trained to do.

I think it is safe to say that

In choosing this second design for their organization's people are implicitly making choices amongst ideals. For homonomy rather than self-seeking, self-serving autonomous striving; for mutual help and nurturance rather than own survival in the system; for inclusion of the criteria of humanness along with the usual decision rules of effectiveness and efficiency. It may be difficult to grasp, but the emergence of a rich complex field of directive correlations within such organizations would make even make them seem to be more beautiful settings to be in.

This relationship between choices of organizational design and choice of ideals is, I think, intrinsic. The error into which I have tended to fall is the assumption that people choose their basic design and then find the appropriate ideals. This is certainly the way that we drifted in the twentieth century. And it is for this reason that I have assiduously followed the moves toward the adoption of the second design in one country after another and in one field of employment after another: For this reason that I was prepared to be involved with the International Council for Quality of Work Life to track and assist such changes.

In quantitative terms the moves toward the second basic design are truly impressive. I also think that my colleagues and myself made useful contributions to this change: at last we showed that the change was a profitable change in modern technologies and modern

societies. We showed also that the changes were profitable to both employees and employers.

Forecasting from theses quantitative trends left us with some feelings of uncertainty. What for instance would happen to this trend if Western societies continued to stagnate with present levels of unemployment, particularly the high level of youth unemployment? What if some of the black social-political scenarios we get from England come true?

Looking back over the post war period I now think that there is another more basic reason for the rapid diffusion and acceptance of what were rather esoteric notions about socio-technical theory and semi-autonomous groups. It was not just that the ideas were sound and experimentally demonstrated. It was because the ideas were consonant with the merging spirit of our times. Since the first angry but lonely howls of the beatniks in the mid fifties we have witnessed a cultural revolution. The traditional forms of dominant hierarchies no longer command unchallengeable respect, loyalty and subservience. That applies to family, church, school, political party, even to the Australian Cricket Board. What is happening in the work-place is but a part of this (Emery 1977)

What if the implication of this for the future of our work organizations?

Firstly, it means that we are confronted with a challenge to move toward the second basic design that is not going to go away. Even continued unemployment is not going to allow a return to the cheap labour philosophy and the daily queues at the factory gates that marked the nineteen thirties. If we are unwilling to offer dignified jobs to youth they will find other ways of defending their newly found dignity.

Secondly, because the change is so pervasive your profession will face challenges on every side. There will be no one neatly defined sector where you can say, “Right, that is the key to the whole situation, here is the answer so let us get on with the job and that will be that.” You are not bridging a river you are trying to swim in a turbulent flood.

As my final comment let me list just a few of the more specific challenges that particularly confront your profession and your professional culture. Your culture and a lot of your professional pride arises from being object-oriented, action-oriented and analytical and concrete in your thinking. In the emergent culture the emphasis is people-oriented, reflective and global, intuitive thinking. There is little room there for extending respect to the traditional engineer, or for that matter to the scientist. The widespread concern about quality of life and conservation has already raised ‘the Numbering question’ for a profession that once thought it was enough to serve the client’s interests (Langley, 1977). The widespread demand for participation in matters that effect oneself e.g. in town planning decisions has corroded the very notion of the expert. So, I suggest that it is not just employers that you need to look at future forms of organization. Getting participative work forms is in fact the easy bit.

I think, gentlemen, that our future’s clock has come full circle since Veblen’s 1922 Manifesto struck the midway hour.

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