

THE ETHICS OF SCIENTISTS AND ENGINEERS: FROM OCCUPATIONAL ROLE RESPONSIBILITY TO PUBLIC CO-RESPONSIBILITY

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Empirical turns in the philosophy of technology take place onto more than one roadway. From the broad thoroughfare of philosophy, any turn onto the more narrow highway of ethics (in contrast to the avenue of epistemology or the boulevard of metaphysics) is sometimes interpreted as a kind of empirical detour. Yet surely, ethics must be part of any empirical turn in the philosophy of technology broadly construed.

From ethics itself, one may also take empirical turns -- from not only metaethics and normative ethics to descriptive ethics, but also from ethical theory to ethical codes of conduct, for example. Indeed, in the professions associated with technology -- meaning primarily and foremost the engineering professions -- discussions of ethics are almost always related, quite empirically and experientially, to questions of the ethical responsibilities associated with the role of being an engineer.

The emergence of philosophically associated engineering ethics thus constitutes in itself what may well be denominated as an empirical turn in the philosophy of technology. What follows is an attempt to give some descriptive content to this turn, and to rise -- but not without empirical references -- some appropriately philosophical questions about it.

1. Role Responsibility: Historic-Philosophical Background

Engineering ethics is a robust example of role responsibility ethics. It is not so much based on ethical theory or ethical principle as it is on a highly descriptive and empirical examination of social roles, social context, and their implications for conduct.

According to a standard social science definition, the term "role" refers to "the behavior expected of the occupant of a given position or status." "All the world's a stage / and all men and women merely players," wrote Shakespeare (*As You Like It* II, 7). Elaborating on this theatrical metaphor,

- an actor assigned to the position (or part) of Hamlet is expected to enact the role of Hamlet, the role being characterized by certain actions and qualities. A person who is assigned to the position of clergyman (or who elects to be placed in such a position in the social structure) is similarly expected to enact the role of clergyman

The concept of role as a social position thus combines descriptive and normative elements. Given, in one way or another, that an individual takes on some socially structured role, especially of a professional character, such an individual becomes subject to certain representations and responsibilities. The responsibilities involved will inevitably have strongly ethical significance.

The idea of role responsibility in ethics can be traced back at least to Plato's *Republic*. There Socrates, having gone down to the Piraeus in curiosity about a new religious festival, is drawn into an evening conversation about justice. This conversation ultimately leads up to expanded descriptions of a hierarchical state in which are distinguished three types of members: rulers, guardians, and artisans. Each class has its distinctive role to play, and justice is defined as the members of a class meeting their particular role responsibilities. Aristotle's remarks in *The Politics* about the naturalness of certain roles may be read as the pursuit of empirical warrant for Socrates' nocturnal ascent. Epictetus, a Stoic follower of Socrates, further endorses acceptance of role responsibility as something akin to a spiritual exercise (*Encheiridion* xvii).

Because of the political character of such roles, their boundary conditions are often defined and enforced by law. Although not explicitly detailed in either the *Republic* or *Politics*, certainly in many cities there have been written codes and statutes governing not only participation in the

military but also, for instance, prohibiting artisans from infringing on one another's areas of competence. The well-known Code of Hammurabi (c. 2000 BCE) even goes so far as to establish detailed legal boundary conditions on the practice of many arts, including those of the builders of houses (see Code of Hammurabi 228-233).

In the classical tradition, Cicero's *De officiis* provides the most well-developed and personalized account of role responsibility. (The Latin *officium*, etymological root of the English "office," although commonly translated as "duty" or "responsibility," itself has a more strongly role-based connotation.) According to Cicero, each person is endowed by *natura* or nature with two *personae* or roles (*De officiis* I, xxx, 107): that which is common to all and distinguishes humans from animals, namely, the role of being rational; and that which is particular to each individual, namely the role of being in a particular body with a particular temperament.

These natural roles are supplemented by two others (*De officiis* I, xxxii, 115): one historically contingent, another voluntarily chosen. A person is historically born into the role of Roman or non-Roman, rich or poor; one chooses to take on the role of philosopher, jurist, or orator -- and to excel in one virtue or another. According to Cicero, *Haec igitur omnia, cum quaerimus quid deceat, complecti animo et cogitatione debemus ...* "All [four of] these, when we inquire into what is decent or proper, we ought to engage in spirit and thought" (*De officiis* I, xxxii, 117).

In short, in order to achieve what Cicero refers to as *decorum* in one's responsibilities (*De officiis* I, xxxi, 110), one should take into account what might be called a four-fold root of role responsibility. In one sense, the role of exercising rational liberty in choosing roles is primary, although most difficult; in another, each human being must be careful to respect and live in harmony with what is given by nature and by history, both to the species and to the individual. For Cicero responsibility is not simply accepting a social role, but involves as well a grounding of that social role in nature and history -- and the deepening that comes from reflective attention to a matrix of role possibilities.

In the Christian tradition the notion of role responsibility continues to be affirmed, but with a degree of detachment that intensifies the voluntary component already identified by Cicero. According to St. Paul, for instance, in Christ "there is neither Jew nor Greek, slave nor free, male nor female" (Galatians 3:28). At the same time, Christians should "be subject for the Lord's sake to every human institution" (1 Peter 3:13), and live out their appointed roles.

Within Christianity, the traditional social role responsibilities, defined by exclusively human institutions and their laws, begin to be interpreted in a radically contingent manner. There cease to be, as with Cicero (and before him, Plato and Aristotle), any unalterably natural roles. In place of the primary distinction between natural and conventional roles there arises one between unconsciously inherited roles (*mores* or customs) and consciously willed ones. For Christians, what is crucial is the distinction between those who live by the law and those who live by faith, that is, between those who have not and those who have consciously taken upon themselves and professed the name of Christ, and as a result live "in the world but not of it."

Within Christian theology there nevertheless emerge new role responsibility distinctions based on what are termed different "states of life": those who have taken holy orders (members of the priesthood) and the laity. For the laity, in turn, there are another two possibilities: the single state and the married state. Intermediate between the laity and the priesthood is the religious state, that is, those who have taken vows to follow not simply the Christian commandments (love of God and of neighbor as oneself; see, e.g., Matthew 22:34-40) but also the counsels (of poverty, of celibacy, of obedience; Matthew 19:10-12 and 21). Within the carefully articulated social order of the religious community (see, e.g., the *Regula* of St. Benedict), role responsibility remains the background of an increasingly refined ethics of principle and conscience.

Although modern Western philosophy explicitly rejects any Christian theological ties, the distinctly modern tradition of ethics largely continues to presume the radically contingent character of all social roles and, as a result, to focus attention on movements from custom and law to ethics, with a consequent emphasis on responsibility according to principle. It is differences over principles, for instance, that divide consequentialism (John Stuart Mill and associates) and deontologism (Immanuel Kant and associates). It is divergent principled

responsibilities that pluralists (such as W.D. Ross) try to integrate. Discussion of role responsibility has, especially in the Anglo-American world, been turned over to the more empirical sciences of sociology and psychology, although some American philosophers in the pragmatist school (such as George Herbert Mead) reintroduced the notion into social philosophy.

In modern philosophy, however, the most sustained attempt to defend and develop role-responsibility ethics is associated with G.W.F. Hegel. In explicit opposition to Kant's high principlism, Hegel develops an extended analysis of *Sittlichkeit*, commonly translated as "ethical life," as the phenomenological foundation for any particular invocation of rational moral principles. Hegel's *Grundlinien der Philosophie des Rechts* (first published 1821) argues for what has become known as an organic theory of the state, in which broad role differentiations between family, civil society, and state define regions of responsibility and the possibility for its further articulation. Like Plato's Socrates of the *Republic*, Hegel views one's role in a social order as providing the framework for ethical behavior; like Cicero, he sees that individual roles may be multiple and subject to development -- both personally and historically.

In English the most sustained version of the associated role responsibility ethics is found in the British Hegelian F.H. Bradley's *Ethical Studies*, especially chapter five, "My Station and Its Duties." Between the aggregate subjective hedonism of utilitarianism and the abstract moral absolutism of deontology, Bradley argues that real morality is found in "our station and its duties, our function as an organ in the social organism."

For Bradley the ultimate end of human action is self-realization. But what is to be realized in and through the self is neither the brute individual, in which there is only subjectivity with no higher aim than self-satisfaction, nor the abstract universal, which is an aim so high as to be only thinkable. Concrete human beings are born into complex social wholes in which they learn to exercise freedom by playing their parts. The concrete level of self-realization is thus neither the individual pursuit of self interest nor the abstract attempt to conform one's actions to a purely rational ideal, but the effort to live up to one's social role -- which at once raises individuals above themselves and brings the abstract universal down into particulars.

Social roles both represent the natural complexity of reality and provide ideals that realize a self. In Bradley's words,

I am myself by sharing with others, by including in my essence relations to them, the relations of the social state. If I wish to realize my true being, I must therefore realize something beyond my being as a mere this or that; for my true being has in it a life which is not the life of any mere particular, and so must be called an universal life.

What is it then that I am to realize? We have said it in "my station and its duties." To know what a man is ... you must not take him in isolation.... What he has to do depends on what his place is, what his function is, and that comes from his station in the organism.

In the 20th century the philosophical credibility of organic role responsibility ethics has been undermined by its close association with religious conservatism (Hindu caste system and Christian racism) and political totalitarianism (fascism and communism). Until the quite recent but only marginally acknowledged ascendancy of role responsibility ethics in the form of professional ethics, the only contemporary moral theorist of stature to have anything to say about role responsibility has been Alasdair MacIntyre, a philosopher with strong if querulous ties to the social sciences.

In his history of ethics, for instance, MacIntyre notes how "when we detach a man from his roles, but still leave him with the concept of 'duty,' that the concept is necessarily transformed." Commenting more specifically on this transformation as it took place in modern English society:

Originally we have a society of well-defined occupational roles and functions, hierarchically arranged, and to this arrangement there corresponds a belief in different stations in life to which God is pleased to call men. When the occupational roles become more important, the notion of a calling by God, but not to any one particular "station," remains.... In such a situation the content

of duty will be blurred. [There is] a move from the well-defined simplicities of the morality of role fulfillment, where we judge a man as farmer, as king, as father, to the point at which evaluation has become detached, both in the vocabulary and in practice, from roles, and we ask not what it is to be good at or for this or that role or skill, but what it is to be "a good man"; not what it is to do one's duty as clergyman or landowner, but as "a man." The notion of norms for man emerges as the natural sequel to this process, and opens new possibilities and new dangers.

Indeed, one reading of MacIntyre's subsequent argument for a revived attention to the importance of the virtues in ethics is to see it an attempt to deal with the new dangers. Virtues may function much like roles, but are nevertheless not socially defined.

2. The Rise of Professional Engineering and Its Role Responsibilities

Although the philosophical defense of role responsibility has fallen into disfavor, what philosophers sometimes describe as the regionalization of ethical principles in many of the areas of applied ethics -- biomedical ethics, computer ethics, etc. -- actually constitutes, as it were, a kind of empirical revival of responsibility in relation to roles. Indeed, this surreptitious resuscitation of role responsibility has taken place mostly from the ground up, with little assistance from professional philosophy. Consider, for instance, the case of engineering ethics and especially the formulation of engineering ethics codes.

The role defining codes of conduct for professional engineers have been formulated in conjunction with the development of engineering as a technical professional occupation, which itself began at roughly the same time as the classical emergence of the Industrial Revolution. (This was also precisely the period during which, on MacIntyre's account, social roles began to be replaced by occupational ones.) This technical professional development may be summarized in terms of four historical phases.

Phase one: The creation of specialized schools of technical engineering education such as the *École Nationale des Ponts et Chaussées* (founded 1747), the *École Polytechnique* (1795), and the U.S. Military Academy at West Point (1804). In this phase, because all engineering was state or military engineering, the unwritten code of conduct for engineers was determined by their roles as soldiers. The basic role responsibility of soldiers is to obey orders; together with technical engineering competency this role responsibility is inherited by the engineering corps.

Phase two: The creation of professional engineering societies independent of the military. Examples include the British Institution of Civil Engineers (granted a royal charter in 1828) and Institution of Mechanical Engineers (1847), the American Society of Civil Engineers (ASCE, in 1852) and American Society of Mechanical Engineers (ASME, in 1880).

The formation of professional societies has continued to follow the emergence of technical engineering disciplines. Examples include

- the American Institute of Electrical Engineers (AIEE), in 1884;
- the Institute of Radio Engineers (IRE), in 1912;
- the merger of the AIEE and the IRE in 1963 to form the Institute of Electrical and Electronic Engineers (IEEE), the largest professional engineering society in the world; and
- the Association for Computing Machinery (ACM), in 1947.

The earliest such professional associations functioned mainly to promote technical competence and solidarity among non-military engineers. Having stepped from well defined military roles into a less structured civilian milieu, professional engineers experienced mutually reinforcing needs to affirm their role distinctiveness and to develop their technical competence. Although

technical competence is the sine qua non of engineering as a profession, in order to exchange technical information engineers also found it useful to create social organizations, which in their turn both required and reinforced social identity.

Phase three: Formulation of the first explicit codes of conduct. The explicit adoption of codes of conduct by professional engineering societies did not take place until early in the 20th century. When it did, it focused on what may be termed internalist issues of occupational role responsibility: loyalty to the profession and to employers, the maintenance of technical knowledge and skill, avoidance of conflict of interest, etc. Such obligations are, for instance, the primary obligations of the 1912 code of the AIEE and the 1914 codes of both the ASCE and ASME.

The very need for explicit codes no doubt derived in part from the increasing size of the engineering profession. In small groups personal apprenticeship suffices to pass on the ethos of a profession. Moreover, the emphasis on loyalty, although stated as though to a client, actually functioned -- since most engineers were salaried employees rather than independent consultants -- as company loyalty. Company loyalty has been interpreted as simply a civilian version of the obedience to authority formerly operative among military engineers.

During this same period, however, some engineers attempted to go beyond notions of company loyalty and to identify in their technical role itself a defining ethical ideal. Just as the role of physician is governed by the medical ideal of health and that of the lawyer by legal justice, so it was argued engineering pursued an ideal at once technical and moral, descriptive and prescriptive: efficiency. During the first third of the 20th century such an interpretation of efficiency even gave rise to attempts to develop technocracy as a positive social-political ideal. Indeed, the concept of efficiency continues to exercise a two-sided, technical-moral influence not only in engineering but also in economics and in politics.

Phase four: Ethics code revision. In response both to further changes in the profession itself and to transformations of the societal context within which engineers work, there began in the middle of the 20th century to take place a revision and reformulation of ethics codes. Internally, as a result especially of World War II, science became what Derek de Solla Price has simply (and aptly) termed "big science"; engineering likewise became "big engineering." Externally, the late 1950s and early 1960s witnessed the emergence of widespread social criticism of engineering as a cause of environmental pollution and a challenge to the quality of material culture.

As a result of both these internal and external factors, technical professional codes of ethics, especially in the United States, while continuing to stress internal role responsibility, began to pay at least nominal attention to externalist issues. For instance, in 1947 the Engineer's Council for Professional Development (ECPD, founded 1932) drew up the first trans-disciplinary engineering ethics code, and in the process committed engineers "to interest [themselves] in public welfare." Revisions in 1963 and 1974 strengthened this commitment to the point where the first of four "fundamental principles" required engineers to use "their knowledge and skill for the enhancement of human welfare," and the first of seven "fundamental canons" stated that "Engineers shall hold paramount the safety, health and welfare of the public...."

As one other example, when the code of ethics of the newly created IEEE was finally articulated in 1974 it included in the fourth of four articles a responsibility to "protect the safety, health, and welfare of the public" and to "speak out against abuses in these areas affecting the public interest." In a 1987 revision of the code this article was effectively if only minimally elevated by the addition of a fifth article after it. But then just three years later in 1990, in a more fundamental revision, the code was simplified to ten much shorter principles, the very first of which is "to accept responsibility in making engineering decisions consistent with the safety, health and welfare of the public."

Some version of this public responsibility plank is now included in all major U.S. engineering ethics codes. This fact nevertheless deserves to be qualified with two comments. First, the fact that public responsibility has been included in engineering ethics codes has not necessarily

made it a fully active ingredient of such codes. The plank is deeply problematic on at least three interrelated counts:

(a) It is difficult to promote and virtually impossible to enforce. Indeed, mechanical engineer and philosopher Taft H. Broome, Jr., has gone even further, arguing that difficulty of enforcement is grounded in impossibility of practice. The problem is that engineering inherently brings about risks.

[E]ngineers cannot assure the health and welfare of the public because risk-free engineering often cannot be achieved. Thus a problem is posed for the incorporation of a public paramount rule into codes of ethics since any rule stipulating what one should do has no logical status if one cannot do it.

(b) It presumes individual actions producing well-defined unique results. In fact, most engineers now work in teams, so that actions are collective even at the technical level, and their actions often have multiple unintended consequences. Indeed, so much are multiple unintended consequences the standard result that the most widely used engineering ethics textbook describes engineering as, in effect, social experimentation. The power and complexity of contemporary techoscientific action, which because of its large-scale consequences calls for public accountability, nevertheless tends in its complexity to undermine the very possibility of such accountability.

(c) What actually constitutes public safety, health, and welfare is almost always contestable and subject to deep public debate. The engineering of nuclear weapons is considered by some to be a means to protect public safety, health, and welfare; by others nuclear weapons are argued to be a threat to public safety, health, and welfare. Take almost any major engineering project and a similar spectrum, if not divide, emerges.

The second critical observation regarding professional engineering attempts to promote public responsibility is that professional technical societies are not all there is to ethics in science and engineering. Professional ethics developments in the professional technical societies have been supplemented in major ways by professional activist associations such as

- the Federation of American Scientists (FAS, founded 1948) and International Pugwash (founded 1957), both of which arose to lobby for the limitation and international control of nuclear weapons; and
- Computer Professionals for Social Responsibility (CPSR, founded 1985), which arose in response to the perceived dangers of President Ronald Reagan's Strategic Defense Initiative.

These and related activist associations of professional scientists -- such as the Committee on Scientific Freedom and Responsibility (CSFR, established 1975) of the American Association for the Advancement of Science and the Union of Concerned Scientists (UCS, Founded 1969) -- clearly understand professional role responsibility ethics to include more than internalist role responsibility issues, and to see public responsibility as more than nominal. For members of the FAS and CPSR, responsibility includes public, not simply technical, action for social responsibility. Such activity requires engineers to become involved in the science and engineering policy making process and even calls for public political activism. They point beyond role responsibility as it has traditionally been conceived and toward what we will term collective co-responsibility.

3. Contemporary Technical Role Responsibility and Its Discontents

What inferences may be drawn from this double sided historical background: the modern philosophical subordination of role responsibility to principle responsibility, and the counterpoint re-emergence and development of engineering role responsibility -- especially of a problematic

engineering occupational (as opposed to social) role responsibility for public safety, health, and welfare?

The historical shift from social role to ethical principle to the re-emergence of role in the form of occupational role is part of a much larger historical replacement of an embedded or integrated social role-based lifeworld with a world of well-differentiated systems. Our point of reference here is the work of Jürgen Habermas. Drawing on the classic founders of modern social theory such as Karl Marx, Emile Durkheim, and Max Weber, and refining the thought of Talcott Parsons, Habermas provides the most extended analysis of the devolution of the traditional life world into a systems world -- or, in alternative terminology, the colonization of the life world by instrumental rationality. In Habermas words, "the uncoupling of system and life world" takes place

in such a way that the life world, which is at first coextensive with a scarcely differentiated social system, gets cut down more and more to one subsystem among others. In the process, system mechanisms get further and further detached from the social structures through which social integration takes place. [M]odern societies attain a level of system differentiation at which increasingly autonomous organizations are connected with one another via delinguistified media of communication: these systemic mechanisms -- for example, money -- steer a social intercourse that has been largely disconnected from norms and values, above all in those subsystems of purposive rational economic and administrative action that Y have become independent of their moral-political foundations.

What Marx and Durkheim had initially analyzed as a process of increasing division of labor and specialization emerges in society at large in three forms. One is the differentiation of societal subsystems of business enterprise (economy), public administration (politics), and law (as an integrative subsystem). Two is the emergence of science, art, ethics, and related forms of knowledge as autonomous realms of culture, followed by their disciplinary and subdisciplinary occupational professionalizations. Third is the transformation of the general social roles of wage laborer and citizen into those of consumer and voter or welfare state client.

Within such a sociological framework, empirically speaking it is not principle-based ethics but occupational role responsibility ethics on which the organization of contemporary techno-social life fundamentally depends. This point is confirmed by the functional prominence of role responsibility ethics in techno-scientific fields, as illustrated by engineering ethics. At the same time, occupational role responsibility is being stretched to the breaking point by its own intensification, as may be summarized in terms of four late 20th and early 21st century trends and three often rehearsed responses.

First, there has occurred, as a consequence of the professionalization of multiple tasks previously carried out in non-technical or private spheres, an enormous differentiation of new roles. Engineering itself provides modest illustration, as it has broadened its functional specializations from research, development, design, and construction to include production, operation, management, and even sales engineers; and its content specialization to include biomechanical engineering, biomedical engineering, biochemical engineering, nanoengineering, and more. Stepping outside the technical fields, the unfortunate *reductio ad absurdum* in this trend is the role professionalization of virtually every work-related activity: janitors become maintenance professionals, friendship becomes professional grief counseling, one hires professional personal trainers to help one get the right exercise, etc. Although this development is primarily manifest as the quantitative proliferation of roles, it inevitably has qualitative implications.

Second, and in parallel, the area for which an individual may be held responsible has been narrowed, as may be illustrated with an example from the sciences that would apply equally well to engineering. In the 1700s there were natural philosophers who pursued natural science. In the 1800s William Whewell coined the term "scientist," and initially there were simply scientists as such (separate from philosophers). This was followed by a period in which it was possible to be a physicist, chemist, or biologist. Today, however, not even the term microbiologist is sufficiently descriptive of a scientific role. As a result some individual scientists may only be

proficient in research they conduct on one specific microorganism, perhaps only in relation to a restricted number of biochemical processes in that microorganism. Individual scientists increasingly "know more and more about less and less," and thus can hardly foresee the consequences of their discoveries for related fields, let alone the possible applications that could result from interactions with other fields. Such an excessive differentiation of roles implies both a formal and a substantial delimitation in individual role responsibility.

Third, the number of roles that any one individual may possibly fill has dramatically increased. Synchronically, one person may well be a structural engineer (that is, a kind of civil engineer) doing research on earthquake remediation, a grant or contract administrator, a professor of engineering, a student advisor or mentor, an academic administrator (as department head or dean), an author -- not to mention a spouse, parent, church member, citizen, consumer, and more. Diachronically, the same person may alter all of these role and/or complement them with literally hundreds of others. Moreover, the interchangeability of individuals and roles has expanded along with individual mobility, both temporally and geographically. This means, practically, that responsibility is more identified with a role than with a person, thereby complicating the responsible organization of professional tasks while significantly diminishing technical professional ethical commitments -- not to mention loyalty.

Fourth, contemporary society is not only characterized by the differentiation of roles but also by the intensified institutionalization of the social-institutional spheres in which the role differentiation takes place. Science, engineering, economics, education, politics, art, religion, and more have all become so institutionally distinct that they largely determine the conditions for their own functioning. Regulation, insofar as it occurs, must increasingly take place internally within each sphere. Scientists regulate science, engineers engineering, economists the economy, and so on.

As a result of this four-dimensional transformation of role differentiation space, technical roles may be said to have become increasingly less robust at the same time that opportunities for role conflict have only intensified, proliferated, and specialized, with individuals more freely floating between roles, although large role aggregates are more rigidly separated from each other than ever before in history. The result is a multifaceted undermining of that very role responsibility which has been the traditional basis of social order -- and for which it is dubious that principle responsibility alone is able to compensate.

Although roles are increasingly central to the functioning of technoscientific society, technical responsibility, while continuing to be framed in terms of roles, is progressively weakened in the moral sense. During the last half of the 20th century in contemporary technological societies, professional roles gained such prominence that, together with their associated expectations and codes of conduct, they constitute one of the major foundations of contemporary ethical problems and dilemmas. Especially the role responsibility of executing assigned tasks from superiors has, outside of professional philosophy, become an important ethical issue of the 20th century.

As was most dramatically demonstrated in the 1962 trial of Adolf Eichmann, strict adherence to role responsibility easily leads to an almost banal immorality. During the trial, Eichmann defended himself by appealing to his role as chief administrator of the mass execution of Jews during World War II, pointing out that his responsibilities were limited to administrative tasks in a hierarchy in which he had to fulfill the orders and follow the instructions given to him by superiors. Although the Eichmann case is exceptionally horrifying, the kind of appeal he made is not so exceptional at all. Repeatedly individuals in technoscientific and contemporary management positions find themselves resorting to precisely this line of reasoning to justify their behaviors. The widely studied Challenger disaster of 1986, for example, may readily be interpreted as illustrating this phenomenon.

This infamous example and its not-so-infamous parallels have not, however, led to any wholesale rejection of individual role responsibility ethics. Instead, in the first instance it is often used to argue that individuals must simply acknowledge more than administrative or technical role. Discussion has therefore focused more on the ethical dilemmas and conflicts that arise when two or more roles conflict. This has varied from an emphasis on conflicts between the

roles of being the member of a family and a professional to issues of the extent to which a technical professional may in certain situations have a responsibility to become a whistleblower. Rather than leading to examination of the ethical foundations of role responsibility itself or of the contemporary role differentiation pace, the dilemmas of role responsibility have become the focus of discussion. To resolve these dilemmas within an occupational role responsibility framework has been the primary intellectual concern, rather than to challenge the ethics of role responsibility itself.

A second attempt to deal with what may be termed the Eichmann problem has been not just to argue for the acknowledgement of more than technical roles but to actually increase technical role responsibility. The historical development of engineering ethics in the United States well illustrates this response. Engineers are not simply responsible for efficiency, nor are physicians single mindedly devoted to health and lawyers to legal justice, but all are as technical professionals in some sense charged with upholding the public good. The problem, with regard to engineers is that it seems virtually impossible to provide technical-professional mechanisms for achieving the end of public safety, health, and welfare. Those who take this issue seriously tend to spill over into activist organizations such as the Federation of American Scientists and Computer Professionals for Social Responsibility -- which, as previously mentioned, point beyond occupational role responsibility.

Still a third attempt to address role responsibility problems has involved attempts to develop an "ethics of technology" or "ethics of science," as well as a variety of studies that typically build on the phrase "social aspect of" in their titles -- e.g., the social aspects of engineering, the social aspects of computing, etc. Such fields of scholarly activity are, however, more concerned with exploring and cataloging the phenomena themselves than with the underlying social orders or the development of normative responses to the occupational responsibility problem itself.

Interdisciplinary studies of the ethics of science and technology nevertheless regularly highlight the extent to which people increasingly feel inadequate to deal with the complex moral dilemmas in which role responsibility places them. The more common phenomenon, in the face of Eichmann-like situations, is not Eichmann-like self justification, but what Austrian philosopher Gunter Anders might associate with the doubt and guilt manifested by "Hiroshima bomber pilot" Claude Eatherly. But was Eatherly really responsible? What about J. Robert Oppenheimer, the leader of the scientists and engineers who designed the bomb? Or, what about President Harry Truman, who ordered the bomb dropping? Or, President Franklin Roosevelt, who established the Manhattan Project? Or even Enrico Fermi and Albert Einstein, who wrote the 1939 letter to Roosevelt that called attention to the possibility of an atomic bomb?

The very complexity of the atomic bomb project calls into question any attempt to accept personal responsibility for the results. Yet certainly Oppenheimer and many other atomic scientists experienced some guilt, and their concerns led to the kinds of public activism illustrated by the founding of the Federation of Atomic (later American) Scientists and the creation of the Bulletin of Atomic Scientists. Anders' paradoxical critique and idealist call for expanding human powers of imagination and responsibility is but the more philosophical manifestation of that intensification and multiplication of moral dilemmas which has led many people to feel that various issues are at once their responsibility and/or beyond their role competencies. The familiar not-in-my-backyard (NIMBY) syndrome in response to industrial construction or waste disposal and personal refusals to limit the consumption of high pollution consumer goods such as automobiles are but two sides of the same coin.

What thus emerges from our description of this four-dimensional transformation of the technical role responsibility space and the three attempts to respond to such a transformation is the picture of a society in which there is an imbalance in the relation between the individual's responsibility for a particular and temporary role and the collective responsibility which is represented by the simultaneous fulfillment of great number of roles for the long-term. This is illustrated by the fact that in increasing numbers of instances it is impossible, even in a hierarchically structured technical professional system to assign to any one person responsibility for solving some particular problem. Who or what role is responsible for nuclear weapons proliferation? For stratospheric ozone depletion? For global climate change? Indeed, who or what role is responsible for even such mundane problems as traffic congestion? For the

malfunctioning of my computer? For the presence of unlabelled genetically modified foods in grocery stores? The chance that any one individual can be identified as responsible for the consequences of our collective actions within and between the myriad systems and subsystems of the technoscientific world has become infinitesimally small. Instead, in most instances it is increasingly the case that some form of co-responsibility for a collective organization and action leading to consequences (both intended and unintended) is operative. At the same time, such collective co-responsibility is difficult to grasp and elusive; it often seems as difficult to pin down as some individual, organization, or even single that might be held accountable for scientific and engineering developments.

4. From Individual Role Responsibility to Collective Co-responsibility

We have described, in an admittedly summary manner but with strong empirical references, a society in which it is difficult for anyone to be held responsible for the consequences of many technoscientific actions. We rely on a theory of occupational role responsibility that is no longer in harmony with existing social reality, in response to which we commonly propose an alternative and expanded notion of role responsibility. The fact is that the consequences of a wide variety of collective actions cannot be reconstructed from the intentions of responsible individuals, and role responsibility ethics can bear only on the consequences of individually and intentionally planned actions.

Individuals assume responsibility for the consequences of their actions if and only if they can intentionally direct those actions and reasonably assess the consequences, both intended and unintended. (Unintended consequences may on some occasions be effectively covered by insurance, as with automobile insurance.) But the consequences of scientific discovery and engineering design often escape all common or natural means of assessment.

Science and engineering exist, in the first instance, within the scientific and technological systems and, subsequently, by means of a complicated transformation and use, are transplanted into the system-specific logics of the economy, politics, and law. None of these system logics are traceable to the intentions of individuals, nor are the possible unintended consequences always assessable. Scientists, who have knowledge that leads to applications that are then criticized by many in society, may rightly point out that they anticipated other applications. Engineers who design products, processes, or systems that wind up actually being used in a variety of ways (guns that kill people as well as protect them, for example) make the same argument. Scientists and engineers may even claim that the possible applications and/or uses are not part of their occupational role responsibilities as scientists or engineers.

What is clearly required is thus some transformed notion of responsibility beyond the simple multiplication of roles or the expansion of occupational role responsibility to encompass public safety, health, and welfare. Indeed, techno-scientific applications can remain ethically problematic even in cases where scientists and engineers have the best possible intentions and users have not conscious intention to misuse or abuse. (Think of the example of automobile pollution.) This situation constitutes the major ethical challenge we face today.

How are we to address the problematic consequences of collective action? Technological risks are examples of special concern. The nature of many technological risks is far beyond the framework of individual responsibility. Such risks arise, as Charles Perrow has argued, as a consequence of an interaction of semi-independent systems, many of which may themselves be in part so complex as to be outside direct control. (Think of the examples of the economy or the legal system as well as those of the various sciences and fields of engineering.) Such risks often cannot even be constrained within the dimensions of some particular time and place, which makes the identification of possible victims impossible. For such risks it is thus not even possible to take out insurance. Many of the technological risks in our society have the same status as natural catastrophes.

In response to this problem, we propose what we will term an ethics of collective co-responsibility. The itemized inadequacies of occupational role point precisely in this direction.

Such a collective ethics of co-responsibility arises from reflection on the social processes in which technological decision making is embedded. (It may even be interpreted as involving a renewed appreciation of Cicero's four-fold root of role responsibility.) That is, any new ethics must deal with the same substance as the old role responsibility ethics, namely with values and norms that restrict or delimit human action and thus enable or guide traditional decision making; but in the new ethics these values and norms will arise not simply in relation to occupational roles. How such an ethics of collective co-responsibility might work in the context of biotechnology has previously been outlined. Here it is appropriate to limit ourselves to indicating three general features and requirements for the implementation of such an ethics.

1. Public debate: To be co-responsible includes being personally responsive. It is clear that the norms of specific technical professions are insufficient because they arise from restricted perspectives. A true ethics of co-responsibility must be both interdisciplinary and even intercultural, in order to provide a standard of justice for evaluating and balancing conflicting occupational role responsibilities. If we fail to provide such an ethics, we inevitably continue to aggravate the clash of cultures and unarticulated hostile responses to particular (globalized) technologies.

According to our view, an ethics of collective co-responsibility is expressed at the level of free (international) public debate in which all should participate. It is unethical and even unreasonable to make any one individual responsible for the consequences and/or (adverse) side effects of our collective (especially technological) actions. It is, however, ethical and reasonable to require individual participation in public debates (subject, of course, to the particular situation), or at least make this the default position for which persons must give reasons for being excused from such a duty. Upon everyone's shoulders rests a particular moral obligation to engage in the collective debate that shapes the context for collective decision making. It is not just engineers who do social experimentation; in some sense all human beings are engineers insofar as they are caught up in and committed to the modern project.

If we trace, for instance, the history of environmental challenges, we see that many issues which depend on the involvement of personally responsible professionals were first identified and articulated within the public sphere. Public deliberation does not primarily aim at creating of itself a reasonable consensus, but serves, among others, the function of presenting different relevant issues to the more or less autonomous systems and subsystems of society -- that is, to politics, law, science, etc. The typically independent discourses of politics, law, science, etc. are called upon to respond to issues raised in public debate. An appropriate response by the appropriate subsystem to publicly identified and articulated issues constitutes a successful socio-ethical response. Conversely, responsible representatives of the subsystems are drivers for new debates, when they publicize particular aspects of an issue that cannot be fruitfully resolved within the limits of some specialized discourse. The continuous interaction between the autonomous subsystem discourses and a critically aware public provides an antidote for frozen societal contradictions between opposing interests, stakeholders, or cultural prejudices.

2. Technology assessment: To be collectively co-responsible involves developing transpersonal assessment mechanisms. Although the institution of the public realm and interactions with the professionalized subsystems makes it possible for individuals to be co-responsive, these deliberations are in many cases insufficiently specific for resolving the challenges with which technological development confront us -- that is, they do not always lead to the implementation of sufficiently robust national or international policies. Therefore all kinds of specific deliberative procedures -- for instance deliberative technology assessment procedures -- must be established to complement general public debate and to provide an interface between a particular subsystem and the political decision-making process. The widely discussed consensus-conferences are one example of an interface between science and politics.

The implementation of ethics codes by corporations also constitutes an interface between the economic sector, science, and stakeholder interest groups, while national ethics committees are often meant as intermediaries between the legal and political system. Experiments with such boundary activities or associations have been, depending on the case, more or less successful. They represent important experiments for enabling citizens to act as co-responsible agents in the context of technological decision making. Yet the absence of adequately deliberative forums

is certainly one reason why we are not yet able to democratically plan our technological developments.

3. Constitutional change: Collective co-responsibility may eventually entail constitutional or structural political change. The initiation of specifically new forms of public debate and the development of transpersonal science and technology assessment processes may eventually require constitutional adjustment. Indeed, the adaptation of specific deliberative principles in our constitutions must not be ruled out.

Consider, for instance, the possible implementation of the precautionary principle, which is inscribed in the European Treaty and now also guides important international environmental deliberations (the Kyoto Protocol on Climate Change, the Biosafety Protocol, etc.). This principle lowers the threshold at which governments may take action to restrict scientific or technological innovation. According to the precautionary principle, one should err on the side of precaution. It does not have to be shown with certainty that bad consequences will follow; it is sufficient if there is an absence of scientific certainty in cases where there is some indication of possible serious or irreversible harm to human health or the environment. The very implementation of such a principle requires new and badly needed intermediate deliberative science-policy structures. It imposes an obligation to continue to seek scientific evidence and enables also an ongoing interaction with the public on the acceptability of the plausible adverse effects and the chosen level of protection. The principle also requires companies to become more proactive and necessarily shapes their technoscientific research programs in specific ways.

Conclusion

The long history of role responsibility ethics as a mediation between ethical systems and social structures was progressively abandoned by modern philosophy in favor of an emphasis on principle responsibility ethics. A kind of empirical witness to the inadequacy of this shift can be found in the grassroots and largely non-philosophical efforts to revive role responsibility in engineering ethics. Yet attempts to enlarge the notion of role responsibility in technical professions such as engineering -- from company loyalty to protection of public safety, health, and welfare -- together with technosocial transformations in the nature of roles themselves, point toward needs for the development in advanced technoscientific societies of something beyond role responsibility. We have named this new attempt to mediate between ethical systems and social structures collective co-responsibility ethics, and indicated some of its central features.

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