Technology Choice

A Critique of the Appropriate Technology Movement

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1990

Westview Press
BOULDER & LONDON

This book is dedicated to Anna,
my daughter,
who has surprised me with joy
and hope.

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Preface

Technology is becoming the leitmotif of the modern world and a linchpin of the international economy. Businesses, governments, community organizations and individuals, seemingly everywhere, are looking to technology as a key to the attainment of their goals. In opposition, of course, there are those who are reluctant to join in with what they see as adulation of technology, and who readily point to the technological causes of human and environmental problems. Even these "unbelievers" seem unable to avoid becoming embroiled in the new rhetoric, however, and unable to escape the technological milieu against which they protest.

This book breaks away from the impasse of the "pro-technology" versus "anti-technology" debate. Instead it concentrates on the idea that there are vital choices to be made in most fields of human endeavor - whether manufacturing, energy supply, transport, health care or food production - between different technological options with contrasting primary or secondary impacts: there is rarely, if ever, one "correct" technical solution to social, economic or environmental problems. It argues that a range of policy areas, perhaps not normally associated directly with technology, can be managed more effectively by paying special attention to the process of *technology choice*.

Technology choice emerged as a critical issue following the pathfinding work of economist E. F. Schumacher. He and his colleagues, with their concept of "appropriate technology", found themselves by the mid 1970s at the forefront of an international movement which offered a fresh approach to grappling with the technological dimensions of human and environmental problems. This book reviews the ideas and experiments of that movement. It examines the grounds for hope that policies based upon expanding the scope for enlightened technology choice might be feasible for both rich and poor communities, in both rural and urban contexts.

Much of the material in the chapters to follow consists of analysis of *ideas* on the nature of technology and its role within society. This book attempts to provide a theoretical framework for answering difficult questions evoked by the concept of technology choice. Its theory was not created from an academic vacuum, however, but was forged through personal experiences I gained while struggling directly with the practicalities of promoting environmentally sound local economic initiatives through community organizations, local businesses and public agencies in the region where I grew up - Western Australia. This study is international in scope and spirit, but it has been shaped by local experimentation. I would therefore like to thank my colleagues from the independent Australian organization *Apace* with whom I have been fortunate enough to share the task of testing these ideas.

Credit also belongs to Peter Newman and Brian Hill, my academic mentors at Murdoch University who have become my valued friends. Special acknowledgment is due to Suzanne, my wife, who made it possible for me to engage in voluntary community development work for two years as I grappled with applying theory in practice. Finally, I would also like to dedicate this book to the late Keith Roby, who was responsible for awakening my interest in the adventure of directing science and technology towards the needs of local communities, but whose tragic early death prevented him from seeing the results of his work.

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An Integrated Framework

There is sufficient unity within the Appropriate Technology movement for it to be recognized as a movement and for its members to communicate with each other or organize common activities. As demonstrated in Part Two, however, there is also great diversity in the movement which has led to much debate and misunderstanding. The weaknesses of the movement have been exacerbated by the lack of an authoritative and comprehensive theoretical formulation of Appropriate Technology. The nomenclature proposed in Part One made it possible to discuss the whole Appropriate Technology movement coherently, thus confirming the possibility of a comprehensive theory of Appropriate Technology. The consensus of ideas upon which such a theory could be based is, nevertheless, it must be admitted, only latent and imperfect. The comprehensive definition of Appropriate Technology put forward in Chapter Two must therefore be viewed as stipulative rather than descriptive.

This chapter aims to enrich the ongoing debate in the field by articulating an integrated framework for Appropriate Technology, based upon a synthesis of the ideas described in Part Two, refined by consideration of the criticisms of Appropriate Technology covered in the previous chapter. Most of the following ideas, at least in a nascent form, are contained in the material already outlined. In this chapter they will be made explicit where previously they might have been largely implicit, and will be articulated systematically rather than in the kaleidoscopic way in which they appear in the literature.

Three Dimensional Mode of Technology-practice

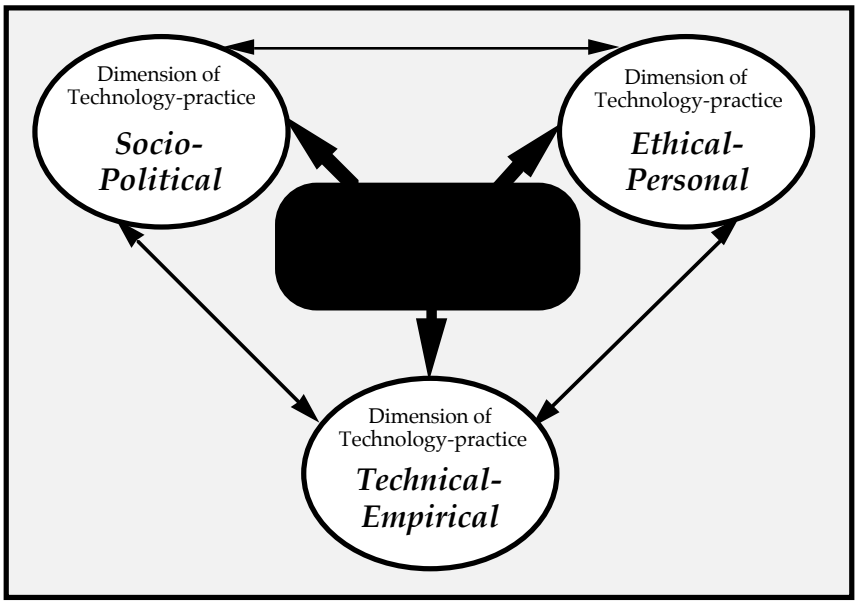
The first major element of the integrated framework is that Appropriate Technology be viewed as involving three dimensions: a technical-empirical dimension, a socio-political dimension and an ethical-personal dimension. It could also be argued that all technology-practice, whether conducted under the rubric of Appropriate Technology or not, involves these three dimensions in varying degrees. The necessary and distinctive feature of Appropriate Technology is that the three dimensions be *harmoniously* integrated. Some proponents of Appropriate Technology focus on one dimension rather than the others, but there is an emerging tendency in the movement for all three dimensions to be taken seriously and to be understood as being interdependent. The purpose of this chapter is to develop this concept systematically and to illustrate how it may clarify the debate on Appropriate Technology and provide a basis for adequately addressing criticisms considered in the previous chapter.

The political criticisms tend to selectively focus on the technical-empirical dimension of Appropriate Technology and argue that socio-political factors are decisive - as if Appropriate Technology does not incorporate a socio-political dimension. Some critics with a technical-empirical orientation, in contrast, point to apparent weaknesses in the Appropriate Technology movement because of its apparent neglect of technical-empirical factors in favour of ethical-personal or socio-political polemic. In his later writings Schumacher places a great deal of emphasis on ethical-personal factors but few commentators effectively draw the links between this aspect of his work and his other work which deals more directly with technology and social-cum-political factors. It is suggested here that the critical discussion of Appropriate Technology would be more fruitful if it recognized the inherent tripartite nature of Appropriate Technology. A framework which incorporates all three interdependent dimensions of technology-practice in Appropriate Technology is illustrated in Figure 10.1.

"Technical-empirical dimension" refers to that aspect of Appropriate Technology concerned with: technologies as artefacts; the tangible components of technical design processes; and the empirically derived knowledge which forms an objective part of technology-practice. "Socio-political dimension" refers to that aspect of Appropriate Technology concerned with: the strategic action of classes of people; social institutions; organizations; and structures which form the main fabric of human corporate life. "Ethical-personal dimension" refers to that aspect of Appropriate Technology concerned with: normative fac-

tors; metaphysics; and matters related to the subjective experience of people or the inner experience of persons, particularly as it relates to their capacity for volition and to act as autonomous centers of power. Each dimension corresponds (very approximately) to the subject matter of technological science (*technologie*), the social sciences and the humanities, respectively.[1]

Figure 10.1 ***Three Dimensions of Appropriate Technology***



The chief claim of this chapter is that a cogent theory of Appropriate Technology becomes feasible if Appropriate Technology is understood as consisting of three mutually interdependent dimensions of technology practice. Theories which exclude any of the dimensions or ignore the mutual interdependency of the dimensions will not be satisfactory, even if such theories exhibit a degree of internal consistency.

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[1] The three dimensions correspond loosely to the "technical", "organizational" and "cultural" aspects of technology-practice identified by A. Pacey (*The Culture of Technology* [Oxford: Basil Blackwell, 1983]).

The criticisms considered in the previous chapter reinforce the importance of the distinction made in Chapter Two between the specific-characteristics and the general-principles approaches to defining appropriate technology. The specific-characteristics type of definition, it was argued, ought only to be used for specific contexts in which the circumstances have been clearly defined. The inappropriate use of the specific-characteristics approach by Appropriate Technology advocates adds some plausibility to the criticisms which have been raised. For example, speaking of "appropriate technologies" in such a way that they must by definition always be small, leads to the possibility that one may thereby promote inequality-inducing technologies which hinder both political reform and economic development.[2]

Adoption of the general-principles approach leads towards a view of Appropriate Technology as a mode of technology-practice exemplified by a special innovation strategy. We have defined appropriate technologies as technologies tailored to fit the psychosocial and biophysical contexts in particular locations and periods, where technologies are defined as artefacts intended to function as relatively efficient means. Because we have adopted an artefacts-based definition of appropriate technology, and because there is an incalculable number of possible contexts in which artefacts may be deployed, it is important to stress the distinction between particular appropriate technologies and the strategy or methodology by which they arise. In other words, it is of fundamental importance to distinguish between *Appropriate Technology* (the innovation strategy, or mode of technology-practice) and *appropriate technology* (a particular artefact or system of artefacts).

The approach adopted here implies that the rationale and method for developing, implementing, maintaining and modifying appropriate technologies is more fundamental than the actual technologies which typify Appropriate Technology at a given time and place. It was demonstrated in Chapters Four and Five that the concept of Intermediate Technology was in fact derived by Schumacher from the dynamic principles of Appropriate Technology (understood as an innovation strategy) rather than from a prior commitment to a given scale

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[2] The work of Prof. A.K.N. Reddy and colleagues from the Indian Institute of Science in Bangalore illustrates this point with reference to the use of Gobar biogas digestors. They have discovered that in situations where traditional feudal-style land ownership patterns prevail the smaller-scale digestors exacerbate inequality between landowners and poor peasants. Maximum benefits to the poor would accrue from the use of larger-scale digestors owned and operated on a cooperative basis by groups of peasants. See, P. Krieg, *Tools of Change,* film, (Freiburg: Teldok Film, 1978).

of technology viewed as "appropriate" independently of circumstances. Much of the subsequent literature of the Appropriate Technology movement has obscured this essentially dynamic aspect of Appropriate Technology.

A static conception of Appropriate Technology is precluded by our stipulated definition of appropriate technology. Unless the process of tailoring technologies to fit their contexts has been pursued, technologies should not be deemed to be "appropriate". Because the biophysical and psychosocial contexts of technology are themselves not static the process of ensuring that technologies are appropriate is necessarily dynamic. Furthermore, the complexity implied by "psychosocial context" indicates that a technology which has been deployed as a consequence of the Appropriate Technology innovation strategy (as described herein), has been selected amidst consideration of the social and political factors which impinge upon that choice. Consideration of social and political factors is not only compatible with the Appropriate Technology concept, but is an essential ingredient of the whole approach.

The *sine qua non* of the integrated framework is that Appropriate Technology be viewed as an innovation strategy aimed at ensuring that technological means are compatible with their context, where "context" is taken to include social and political factors and associated normative goals.

Technological Fit

The second major element of the integrated framework proposed here is the notion of the *technological fit*. This involves the two subnotions of *technological means* and *technological niche*.[3]

Technological Means

Qualifying the word "technology" with the adjective "appropriate" implies that technology cannot be properly assessed or

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[3] The importance of the notion of "fit" for Appropriate Technology has been acknowledged, for example, by G. McRobie (*Small is Possible* [London: Jonathan Cape, 1981], p. 28). A. R. Drengson has featured the notion prominently in his philosophical outline of Appropriate Technology (see, "Toward a Philosophy of Appropriate Technology", *Humboldt Journal of Social Relations*, **9**, 2 [1982], 161-176).

evaluated without reference to something other than itself. To be appropriate, technology must be appropriate *to* something or appropriate *for* some purpose. The notion of Appropriate Technology stresses that technology does not exist in a material and social vacuum; it stresses technology's function as an instrument or a means.

Means are defined in the *Oxford* dictionary as that by which results are brought about. The etymology of the singular term "mean" refers to that which in some way mediates or occupies a middle position among things or between two extremes; in its plural form, "means", it denotes that through which an end is attained.[4] Hence, when used to denote a process or instrument (and when used as a statistical concept - in the singular) the term "means" always invokes the quantities or factors between which the means mediates. Defining technology *inter alia* as means reinforces the emphasis on the context of technology which is contained in the concept of Appropriate Technology. These semantic considerations are not included here for reasons of pedantry, but because of their implications for technology-practice: the very concept of technology points to the need for skills in assessing meta-technical factors. Thus, by definition, Appropriate Technology may not be practiced solely by technical specialists in their capacity as technical specialists.

The notion of the technological fit derives from the view that technology ought to be understood in relation to something other than itself. The word "fit" implies that one factor *corresponds* to another. The technological fit is therefore the degree to which a technology corresponds with its context.

Technological Niche

The notion of the technological fit may be explained by borrowing terminology from the science of ecology. In ecology particular species are understood by how well they are adapted to particular ecological niches. A species' survival prospects are enhanced by it being well adapted to its niche. The niche is understood as either a subdivision of a habitat or as the "role" of a species in the environment. Some schools

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[4] D. D. Runes, et al., *Dictionary of Philosophy* (Totowa, N.J.: Littlefield Adams, 1962), pp. 192-193.

of thought argue that only one species may occupy each niche, and others argue that inter-species competition may exist within a niche.[5]

The technological equivalent of the species is a particular technological artefact (understood as a means). Similarly, the circumstances in which a particular technology is to operate may be viewed as a kind of niche - a *technological niche*. Thus, a technology would correspond to a particular technological niche. The particular circumstances which constitute a technological niche may be referred to as the *psychosocial* and *biophysical* context of the technology in question. Psychosocial includes the ethical goals, political framework, economic structures, social institutions, philosophical perspectives, ideological commitments, aesthetic sensibilities, personal aspirations or psychic needs of people. Biophysical includes the physical-cum-biological needs of people and other species, geographical parameters, the availability of physical resource endowments, thermodynamic principles, environmental limits, physical constraints and the overall ecological profile of a region. The term "technological niche" may be used to denote a psychosocial and biophysical context which prevails at a particular location and time.

In the same way that a species may be described in terms of how well it occupies an ecological niche, the appropriateness of a technology may be described in terms of its compatibility with a given psychosocial and biophysical context - that is, in terms of how well it occupies a given technological niche. A good technological fit is achieved when there is a high degree of compatibility and a poor technological fit is achieved when there is a low degree of compatibility.

The idea that a poor technological fit is possible implies that an "inappropriate technology" may still operate or be practicable - but only up to a point. It also implies that the costs of an inappropriate technology choice may not be immediately apparent or may not necessarily surface at the point of application. The possible hiatus between the deployment of a "poorly fitting" technology and its harmful or undesired impacts is a reason why the appellation "appropriate" is not superfluous. A good technological fit does not occur automatically, partly because the feedback to those who choose a technology is generally neither immediate nor adequate. By the time the investment of resources to a technological project is completed the technology may

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[5] For a detailed discussion of the concepts of *species* and *niches*, see: C. J. Krebbs, *Ecology: The Experimental Analysis of Distribution and Abundance* (New York: Harper and Row, 1972), pp. 211-242; M. Allaby, *A Dictionary of the Environment* (London: MacMillan, 1977), pp. 110, 337 and 452.

exhibit a degree of infrangibility, making it incapable of modification to achieve a better technological fit.

The arguments just applied to a particular technological artefact would also apply to a technological system, so long as that system could be contained within the environment which constituted its context. Our notions of the technological niche and of the technological fit point to the inherently problem-filled nature of technology choice. The fact that technology is part of technology-practice and that a particular technology is always situated in a particular context implies that decision-making criteria may not be reduced to a simple technical format.

Dynamism of the Technological Fit Concept

Some commentators may charge that the artefacts-based definition of technology adopted herein leads to a static conception of Appropriate Technology. It could be suggested that the focus on niches neglects the complex dynamics of the real world. This criticism is misdirected. Insofar as the psychosocial and biophysical conditions of a given place alter over time, then the technological niches associated with that place also alter over time. The notion of the technological fit which underpins our concept of Appropriate Technology requires that assessments of a technology's appropriateness be time-specific and location-specific. Changes in time and place will alter the design parameters of technology. The notion of technological fit does not allow for specific technology design parameters to be applied statically. Appropriate Technology points to the need for ongoing technological innovation in a given region and ongoing revision of design parameters rather than reliance upon a standard once-off "technical fix".

The dynamism of the technological fit notion may be illustrated further by the allegory contained in the phrase "tailored to fit" in our definition of appropriate technology. The association with the *tailoring* of clothes is intentional. Tailoring involves the use of formal techniques and rules which, while essential, are not sufficient to ensure a high quality suit of clothes. Quality tailoring requires interaction between the tailor and the client to determine his or her shape, size, tastes and requirements. This is made even more important by the fact that peoples' dimensions and preferences change with age. A durable suit that looks splendid on the hanger but which does not fit is of little value to the client. Tailoring is a dynamic activity which requires the exercise of professional judgement by the tailor - not just the relatively routine tasks of following pre-set patterns and assembling components.

The phrase "tailored to fit" stresses the human factor in technology-practice.

Appropriate Technology, as we have defined it, points to the need for dynamic interaction between technologists, the users of technology, the environment of the technology and the technology itself.

Corollaries of Appropriate Technology

The features of Appropriate Technology which form the foundation of the integrated framework are that it is a mode of technology-practice characterized by an innovation strategy aimed at achieving a good technological fit.

When portrayed in the foregoing terms Appropriate Technology may appear to be self-evident and little more than common sense. It does not follow, however, that because ideas may appeal to common sense they are *ipso facto* properly understood and thoroughly implemented in society at large. One of the main contributions of the Appropriate Technology movement has been to point out that, despite the immense growth in the deployment of technology throughout the world, most basic human problems - such as poverty, maldistribution of wealth, political malaise or environmental degradation - persist. In other words, while the basic principles of Appropriate Technology may be no more than common sense they do not appear to have been *apprehended* in normal technology-practice on a widespread basis. In addition to the socio-political constraints considered earlier, a partial explanation for this may lie with a failure to appreciate certain corollaries of the concept. Some of these corollaries will now be considered before explicating additional features of the Appropriate Technology innovation strategy.

Non-neutrality of Technology

Appropriate Technology is incompatible with the view that technology is "neutral" in socio-political and normative terms.

It is often suggested that technologies are equally open to use for either good or bad, or that the social and political status of technology is dependent entirely upon the manner in which it is used. In other words, it is suggested that particular technologies do not possess *intrinsic bias* vis-a-vis human interests and environmental impacts. Similar comments are made with regard to the environment; viz. that technologies

do not in themselves lead to certain types of environmental impacts. In contrast, the concept of Appropriate Technology implies that technologies have an *intrinsic propensity* towards certain types of social and physical impacts rather than others.

Technological science (i.e., *technologie*), on the other hand, appears much more open to being employed for a variety of different human purposes or environmental regimes than do actual technologies. The extent to which this is so is open to debate because technological science takes place within a social context and inevitably reflects something of that context. Technologies, however, in their capacity as artefacts are not, in the main, malleable and are therefore not neutral. Technological science could be said to possess a limited degree of neutrality. Although its neutrality is not unequivocal, the degree of flexibility which technological science does possess at the level of application is a key to the viability of the Appropriate Technology innovation strategy.

An example may illustrate these points. A typical modern nuclear-fission electrical power plant (i.e., a technology) may not readily be used for anything other than producing electricity (or radioactive materials).[6] It also embodies characteristics of the social setting in which it was spawned: e.g., a high degree of organization, centralization of control over energy production and use, extensive grid-based electricity distribution, sophisticated technical back-up facilities, necessity for strict safety procedures and discipline, high levels of capital accumulation, and necessity of relatively stable access to specialized sources of high-grade materials. Such a plant may not be readily operated in a setting which does not exhibit similar characteristics; hence, its possible benefits may not be enjoyed freely by all communities alike. Furthermore, when introduced into a region which does not already possess the appropriate conditions, the technology will create pressures for such conditions to be generated. Technological science - incorporating inputs from the science of thermodynamics, mechanical, civil and electrical engineering, or from cybernetics - is capable of producing a range of different energy technologies. These may involve: production of liquid fuels from biomass; a variety of fossil fuel systems; hydropower; energy efficiency devices; photovoltaic or solar-thermal systems; aerogenerators; and human or animal powered machines.

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[6] For an exposition of the inflexibility of nuclear power technology (especially breeder technology) and of the consequent difficulty it presents for political control when adopted, see D. Collingridge's book, *Technology in the Policy Process: The Control of Nuclear Power* (London: Frances Pinter, 1983)

Each of these products from technological science may reflect a different range of corresponding conditions.

The foregoing theme may be stated in a different way. To speak of a technology as being "neutral" is to imply that any range of ends may be attained by the deployment of given means. That is to say, that there is no functional and intrinsic connection between ends and means. Appropriate Technology, in contrast, implies that an intrinsic and functional relationship exists between ends and means: the two are not independent. In other words, ends are inherent in means; given means evoke certain ends.

Technology as a Determining Factor

A second corollary of Appropriate Technology is that technology-practice, incorporating particular technologies, may act as a determining factor in society. That is, the introduction of a new technology-practice may exert a dynamic influence on the structure of society. Adherents of Appropriate Technology tend to believe that technology is a key ingredient in the achievement of social goals.

Describing technology-practice as a determining factor in society does not require adopting a commitment to the doctrine of technological determinism. It is possible for technology-practice, or even technology, to exert a determining influence upon other factors in society while at the same time incorporating reflections of those factors in its structure. In other words Appropriate Technology implies *mutual interdependence* between technology and other factors in society. This picture of technology in society is not only promulgated by those operating under the rubric of "Appropriate Technology". Hill is an example of a scholar critical of technological determinism who also shares this perspective:[7]

> Technologies and technical change are … not autonomous forces, but are produced *within* a social, economic and cultural context; thus their meaning to society depends upon the world views that society holds at that time. Both the type and pervasiveness of technical change are limited by the wider social and economic conditions. Equally, however, change in the basic techniques of a society is likely to create pervasive change

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[7] S. Hill, "Technology and Society", in *Future Tense? Technology in Australia*, ed. by S. Hill and R. Johnston (St. Lucia: University of Queensland Press, 1983), pp. 28-29; Hill's use of "techniques" and "technical" corresponds to our use of "technologies" and "technological".

throughout the society's economic and social structure, culture and world views.

Appropriate Technology implies that the role of technology in society is dynamic and not simply passive. The movement's rhetoric, nevertheless, does portray technology an increasingly dominant factor in the dynamics of society.

Heterogeneity of Technology

The designation of one technology as "appropriate " and another as "inappropriate" implies that technology is not a monolith, incapable of differentiation. Thus, the third corollary of Appropriate Technology is that technology is heterogeneous.

The popular usage of generic phrases like "*the* new technology" or "technology's impact on society" reveals a tacit assumption that technology is some kind of single entity, exogenous to the processes of human society. In colloquial terms, technology is often portrayed as "a thing out there". It is frequently treated as a homogeneous phenomenon to be either accepted or rejected *in toto*. Technical specialists often speak of having discovered or engineered *the* technically correct solution to a problem, as if technology could somehow be isolated from the complexity of its cultural, political and material context. This tendency to reify technology into a monolith reinforces the sense of powerlessness of the individual which may increasingly be found in urban-industrialized cultures. It is also reflected in political rhetoric, where debate is often polarized between those who "favour" technological development and those who are "against" it.

Appropriate Technology transcends the pro-technology versus anti-technology debate by rejecting the view that technology is homogeneous. The concept assumes that technology is a heterogeneous collection of phenomena and that it is possible for technologists and others to develop a diversity of technologies to match the diversity of psychosocial and biophysical contexts (i.e., technological niches) in a region. This principle is embodied in the adage, "there is more than one way to skin a cat"!

The emphasis in Appropriate Technology on the heterogeneity of technology does not require that there be no unity to the diversity of

technology nor that technology does not exhibit systemic tendencies.[8] Rather, it implies diversity within unity. It also implies that the increasing tendency for modern technologies to form part of a *system* of technologies, while a dominant feature of technological society, is not absolute. Not all technologies require substantial systems for their successful operation; and, in cases where appropriate technologies do necessarily form part of modern systems, it does not follow that such systems negate the principles of the technological fit. There appears to be no reason why a diversity of *technological systems* is not possible - in addition to a diversity of *technologies*.[9]

Appropriate Technology may be seen as a response to the convergent and unifying tendencies in modern technology; but, it is a response which recognizes the historical heterogeneity of technology and which aims at cultivating this aspect of technology.

Technological Context

The fourth corollary of Appropriate Technology is that technology always operates in a context of some kind and that this context ought to be uppermost amongst factors affecting the design or choice of particular technologies. This supposition was implied by the earlier outline of the technological niche concept and does not require much elaboration. Two further points, however, should be raised here.

Firstly, it is facile to speak of "advanced" or "sophisticated" technology, for example, without reference to the context of the technology. Given that a technology may be viewed as a means towards an end, it follows that assessments of its sophistication should involve examination not only of the complexity of the artefact as a discrete entity, but

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[8] The subject of the systemic nature of technology deserves considerably more attention than is possible in this study. J. Ellul (*The Technological System* [New York: Continuum, 1980]) has written extensively about the threats to human autonomy of the "technological system" and his arguments do raise serious questions about the meaning of the "technological fit" concept. For example, he writes, "It is absolutely useless to regard one technology or one technological effect separately; it makes no sense at all. Anybody doing that has simply no understanding of what technology is all about, and he will find lots of cheap consolations" (p. 107). We should simply note, at this juncture, that this synthesis of Appropriate Technology does not depend upon a non-systemic, atomistic approach to technology.

[9] Even Ellul, the most ardent exponent of the systemic interpretation of technology, does not rule out the role of people in affecting technological systems; e.g., "Thus, in describing the system, I do not exclude the initiatives and choices of individuals, but only the possibility that everything boils down to them" (*ibid*., p. 87).

examination of how well it achieves the end which it is ostensibly meant to serve.

It was argued earlier that technological ends are, in one sense, immanent in the means. That discussion may be extended by making a distinction between the end immanent in the means (labelled "intrinsic end") and the end which is held as the human purpose for which the means are employed (labelled "extrinsic end"). In principle it is possible for the intrinsic and extrinsic ends of a technology to differ, in which case a poor technological fit is attained. The concept of Appropriate Technology implies that true technological sophistication is attained when the extrinsic and intrinsic ends of a technology are identical or very similar. Thus, it could be said that a technology "works" when a match is achieved between its intrinsic and extrinsic ends.

It could be suggested that there is little value in what appears to be a pedantic distinction between intrinsic and extrinsic ends, because all good technologists would automatically ensure that a match between the two is achieved; viz., it may be taken for granted that technologists will provide technologies which work properly. This suggestion pinpoints one of the main substantive claims of the Appropriate Technology movement: it *may not* be taken for granted that technological means will necessarily effectively serve the extrinsic ends for which they are intended. A technology may "work" properly in the sense that it functions efficiently to attain its intrinsic end (which may be equivalent to an extrinsic end adopted by the technologist), but without "working" properly from the point of view of the extrinsic end of the technology users.

Appropriate Technology embodies a broader concept of efficiency than may be held by a technologist concerned mostly with "intrinsic" efficiency. A truly sophisticated technology consists of means which efficiently serve both extrinsic ends and intrinsic ends. In other words, the *content* of technology ought to bear some relation to its *context*.

The second main point about the context of technology concerns the "psychosocial context". The psychosocial context of technology is not a static set of conditions; it includes the political and normative goals of a particular community. The definition of Appropriate Technology we have adopted therefore requires that unless a technology has been selected to serve the political and normative goals of the community or group of people in question it should not rightly be deemed "appropriate". Our concept of Appropriate Technology precludes, by definition, a narrow technicist approach, indifferent to political factors.

Technology Choice

A fifth corollary is that once the context of technology has been identified and the objectives for technological innovation articulated, there still remains a choice amongst alternative technological means to achieve those objectives. *Technology choice* is a cardinal feature of the Appropriate Technology innovation strategy.

Evidence for the possibility of technology choices has been surveyed in earlier chapters. Two examples here may help illustrate the character of such choices. Firstly, given an objective of preparing to adequately meet a region's energy-supply requirements by early in the twenty-first century, a choice may still remain between, for example, a fossil-fuels, a nuclear or a solar/conservation oriented strategy - with the concomitant technology mixes.[10] Choices between alternative energy policies and associated mixes of energy technologies are not just about choices of technology; they are also choices about such matters as the quality of life and the style or structure of society.[11] Another example of the possibility of choice lies with the problem of the disposal of human waste. The technology exists for: centralized sewage systems, which often dump partly treated wastes at sea or in rivers; local-community wastewater recycling depots; or, domestic grey-water recycling systems and compost toilets.[12] Each of these options is feasible from a strictly technical point of view. The choices themselves, however, are not reducible to a technical format. Each community must make a choice (or have the choice made on its behalf) about which option or combination of options it will adopt. Such choices are not straightforward, however, because they require comprehensive consideration of the parameters of the psychosocial and biophysical context of the community.

The distinction made in Chapter Two between *technical* and *technological* is important. The scope for real choice between alternative options may differ in each case. Technical phenomena are *dedicated* to efficient, rational, instrumental, specific, precise and goal-oriented op-

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10 Cf.: K. R. Roby, "Towards a Sustainable Energy Society", in *Prospect 2000: A Conference on the Future*, ed. by S. T. Waddell (Perth, Aust.: Australian and New Zealand Association for the Advancement of Science, 1979); M. Diesendorf, ed., *Energy and People: Social Implications of Different Energy Futures* (Canberra: Society for Social Responsibility in Science, 1979).

11 C. A. Hooker, *Energy and the Quality of Life: Understanding Energy Policy* (Toronto: University of Toronto Press, 1981).

12 Office of Technology Assessment, *An Assessment of Technology for Local Development* (Washington, D.C.: U.S. Government printing Office, 1981), esp. pp. 147-194.

erations; viz., technical phenomena exhibit a high degree of technicity. Technicity is a necessary feature of technology. The degree to which technology is dominated by technicity, however, may vary considerably between different technologies. When, in the course of history, the *available* technology for a particular field of technology-practice becomes dominated by technicity, very few significant choices may actually be *available* - even if there are no physical reasons, *in principle*, why such choices may not exist. For example, technology-practice in the field of banking appears to be growing increasingly technological - as expressed in the use of electronic means for funds transfer, credit provision, accounting and customer services. The need for compatibility between the technological systems of different financial organizations appears to be forcing international convergence in banking technology-practice and higher levels of technicity in that technology-practice. If these trends continue they could reduce the available choice to organizations and individuals of means for conducting financial transactions; e.g., it could become difficult to make purchases in some communities without access to electronic funds-transfer-terminals and the appropriate magnetic credit/identification card.

Even in fields where technology-practice is highly technical, e.g., electronic computing, it does not appear that technology choice is completely excluded. It is possible for an organization to choose between the use of a main-frame computer with a series of terminals or a collection of microcomputers (operated either separately or connected in a network). Furthermore, even for a given piece of computer hardware there may be a wide choice of software packages available for a given activity (such as word-processing) - each of which is highly technical but nevertheless different.

If "technology" refers to an individual technical process (e.g., direct conversion of solar radiation to electricity by amorphous silicon cells) there will probably only be limited room for choice within that process; although, even with a technical process such as this it is not obvious that *one* option is the superior option. If, however, "technology" refers to a general field of technology-practice (e.g., conversion of solar energy into a form of energy which is useful to human beings) the range of possible choices is broadened.

Ellul's somewhat prodigious writings on technology are marred by an apparent failure to apply the distinction between technology and technicity consistently.[13] For example, he avers:[14]

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[13] See, e.g.: *The Technological Society* (New York: Knopf, 1964) and *The Technological System* (as cited above). This apparent failure may perhaps be explained partly by Ellul's

> There is no real choice, strictly speaking, about size; between three and four, four is bigger than three. This is not contingent on anybody, no one can change it or say the opposite or personally escape it. Any decision about technology is now of the same order. *There is no choice between two technological methods*: One foists itself inevitably because its results are counted, are measured, are obvious and indisputable. … there we have a decisive aspect of technological automatism: it is now technology that makes the choice *ipso facto*, with no remission, no possible discussion, among the means to be used. Man is absolutely not the agent of choice.

His views appear to contradict one of the main tenets of Appropriate Technology - that people may make genuine technology choices. It would appear, however, if we allow him certain literary licence, that Ellul's analysis applies primarily to technological phenomena and technological environments which exhibit a high degree of technicity. Technology choice, vis-a-vis Appropriate Technology, applies most readily within general fields of technology-practice rather than within specific highly technical processes. Within a given field of technology-practice the dominance of technicity may vary considerably from case to case, leading to varying scope for technology choice from case to case. As the empirical evidence surveyed in earlier chapters indicates, Ellul's repudiation of technology choice is largely rhetorical and may not be sustained at the level of real technology-practice.

In conclusion, our synthesis of Appropriate Technology, strengthened by consistent use of the semantic conventions adopted in Chapter Two points to the importance of technology choice for sophisticated technological innovation.

Control of Technology

A sixth corollary of Appropriate Technology is that it is actually possible for people to control technology. The control of technology is closely related to the heterogeneity of technology and the possibility of technology choice. Unless technology may be controlled by people the notion of tailoring technology to fit its psychosocial and biophysical context makes very little sense.

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highly idiomatic style, but even allowing for this it is often not clear whether he is referring to technique, technology, technicity, technology-practice or his ubiquitous *La Technique.*

14 *Technological System*, pp. 238-239 (emphasis added).

Control of technology, in this context, involves more than the possibility of people being able to manipulate technologies according to technical rules within the framework of a technological system. It involves people being able to master and direct technology in accordance with principles which are derived independently of the imperatives of the technology or technical system in question. The extent to which this is possible and the conditions under which it might be possible are contentious and will be considered more fully in the next chapter.[15] It should be noted here that the capacity of people to control technology is not automatic; it is highly contingent upon the exercise of certain human potentialities such as volition, political acumen, critical reflection, technological prowess, and organizational imagination. These potentialities require cultivation, and therefore provide no *guarantee* of the success of efforts aimed at the social control of technology. The grounds of hope for the future of Appropriate Technology, however, remained linked to the capacity of human beings to control technology.

Technology Assessment

The seventh corollary of Appropriate Technology is that the attainment of a good technological fit will normally require the use of technology assessment procedures.

Tailoring technology to fit the context in which it is to operate requires assessment of the range of technologies available, the nature of the technological niches in question, and the likely impacts of the introduction of alternative technologies. The complexity of modern urban-industrialized societies, and of their impact on traditional societies, means that technology assessment cannot be conducted adequately on an ad hoc basis.

Acknowledgement of the need for technology assessment procedures is not unique to the Appropriate Technology movement. It has received serious attention at an international level.[16] Considerable debate has

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15 A notable debate on this matter is emerging in the literature. See, e.g.: D. A. MacKenzie and J. Wajcman, eds., *The Social Shaping of Technology* (Milton Keynes: Open University Press, 1985); D. Collingridge, *The Social Control of Technology* (London: Frances Pinter, 1980); R. Johnston, "Controlling Technology: An Issue for the Social Studies of Science", *Social Studies of Science*, **14** (1984), 97-113; D. Collingridge, "Controlling Technology (Response to Johnston)", *Social Studies of Science*, **15** (1985), 373-380; R. Johnston, "The Social Character of Technology (Reply to Collingridge)", *Social Studies of Science*, **15** (1985), 381-383.

16 See: F. Hetman, *Society and the Assessment of Technology: Premises, Concepts, Methodology, Experiments, Areas of Application* (Paris: Organization for Economic Cooperation and Development, 1973); Organization for Economic Cooperation and

ensued over the effectiveness of technology assessment as a tool for addressing complex social and environmental problems, and some doubts have been raised as to whether it may be cost-effective (should a comprehensive assessment be desired) and whether the scope of available methodologies is great enough to make them generally applicable. A full review of the technology assessment literature is not possible here.[17]

There are at least two important implications of Appropriate Technology for technology assessment. The first concerns methodology and the second concerns assessment criteria.

Some reviews of dominant technology assessment practices suggest that the methodologies employed *a priori* effectively preclude consideration of policy options which accord with Appropriate Technology.[18] This is partly due to a tendency to exclude information from assessments which cannot be readily quantified. Many of the factors which constitute the psychosocial and biophysical context of technology may not be reduced to a numerical form. Thus, Appropriate Technology points to the need for more comprehensive approaches which incorporate qualitative assessments as well as quantitative assessments. The importance of people and of local communities in the Appropriate Technology innovation strategy also suggests that technology assessment procedures conducted by technocratic elites, independently of participation by people from the communities where proposed technologies are deployed, may be inadequate and probably counterproductive.

Appropriate Technology also points to the need for careful reflection upon the range of criteria used to guide assessments; viz., all pro-

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Development, *Methodological Guidelines for Social Assessment of Technology* (Paris: Organization for Economic Cooperation and Development, 1975); Coates, *Federal Government*; P. Behr, "Office of Technology Assessment", *Environment*, **20**, 10 (1978), 36-38; R. Ishida and H. Eto, "Integrating Assessment in National Technological Policy", *Impact of Science on Society*, **28**, 2 (1978), 139-146.

17 The following are useful sources: H. Brooks, "Technology Assessment as a Process", *International Social Science Journal*, **25**, 3 (1973), 247-256; W. F. Hederman, *Assessing Technology Assessment* (Santa Monica, Cal.: Rand Corporation, 1975); J. I. Gershuny, "Technology Assessment: Oversold and Under-achieving: Second International Conference on Technology Assessment", *Futures*, **9**, 1 (1977), 74-76; A. Porter, et al. (*A Guidebook for Technology Assessment and Impact Analysis* [New York: North Holland, 1980]); R. Kasper, ed., *Technology Assessment* (New York: Praeger, 1972); F. T. Ayers, "The Management of Technological Risk", *Research Management*, **20**, 6 (1977), 24-28.

18 See: Carpenter, "Technoaxiology". Cf.: S. R. Carpenter, "Philosophical Issues in Technology Assessment", *Philosophy of Science*, **44**, 4 (1977), 574-593; K. S. Schrader-Frechette, "Technology Assessment as Applied Philosophy of Science", *Science, Technology and Human Values*, **33** (Fall 1980), 33-50.

cedures are based upon some criteria which, in turn, reflect certain socio-political interests and normative biases. It is important for assessment criteria to be examined to prevent inappropriate *de facto* criteria being adopted tacitly.

From the perspective of Appropriate Technology, unifactorial approaches to technology assessment which depend upon a single criterion, such as internal technical efficiency or short term financial profitability, ought to be avoided. Appropriate Technology requires a multifactorial approach which takes into account a diverse range of assessment criteria. Criteria which might be included in such an approach could address the following issues: technical efficiency; economic status; socio-economic bias; cultural compatibility; environmental impact; resource requirements; ownership potential; scientific input; aesthetics; durability; social value; capital cost; political bias; origins; employment impact; technical sophistication; development pattern; or, scale.

Local Focus in Technology-practice

Finally, the basic concept of Appropriate Technology, combined with the aforementioned corollaries, points irrevocably to the importance of a local or regional focus in technology-practice.

A focus on local conditions and the parameters of actual local communities was demonstrated earlier to be a central aspect of Intermediate Technology. The theme recurred in our survey of the broader Appropriate Technology movement. Hence, by emphasizing the local focus of the movement, we are reiterating an observation of historical fact. The local focus is also *logically* implied by the very concept of Appropriate Technology.

The notion of the technological fit is not very meaningful if technological niches are not understood as geographically based niches. Appropriate Technology would be quite prosaic if it were not for the fact that it embodies the presumption that technological niches vary between geographical locations. The fact that biophysical and psychosocial conditions vary immensely between locations - both urban and non-urban - may be taken as generally accepted and as requiring no further justification here. It is not so widely comprehended, however, that this has major ramifications for technology-practice. The diversity of localities, both between and within countries, means that a technology which exhibits a good "fit" in one location will not necessarily achieve the same in another. The parameters of technological

niches cannot be deduced from abstract principles - they need to be based upon observation of real conditions in *particular* places. This is the prime implication of the general-principles approach to Appropriate Technology.

The tendency for a number of Appropriate Technology advocates to adopt the specific-characteristics approach to defining Appropriate Technology, while nevertheless inadequate in certain respects, reflects the local focus inherent in Appropriate Technology. In the final analysis, the general-principles approach is vacuous unless translated into tractable and specific terms at the level of particular localities and regions.

Endogenous Technological Development

In this chapter it has been proposed that Appropriate Technology be viewed above all as a mode of technology-practice aimed at achieving a good technological fit. Having articulated some important corollaries of this view we are now in a position to outline another essential theme which forms part of the integrated framework for Appropriate Technology: endogenous technological development. At least four important aspects of endogenous technological development may be identified: endogenous innovation; self-reliance; community development; and, the technological mix.

Endogenous Innovation

"Endogenous technological development" refers to social and economic development in which technology plays a significant role and which is generated and sustained primarily by dynamics which emanate from within the country or community in question.

Innovation is an important part of technological development because, amongst other reasons, the environment in which most economies operate is not static. Continual innovation is required to ensure that technology and the industry with which it is associated are adapted to their changing environment. This is not to imply that the environment in which technology is deployed is not itself determined by that technology, but rather that it is also subject to many other determinants (e.g.: foreign competition, resource depletion, changes in consumer preferences or other social pressures). The technology in a community may become inappropriate to its environment - even in cases where it may

have originally been selected according to the principles of Appropriate Technology. Thus, endogenous innovation is an essential part of endogenous technology development.

Endogenous innovation is the process whereby the impetus and resources for the transformation of a community's technology stem from within that community rather than from an exogenous source. A policy commitment to a local focus in economic development leads directly to the notion of endogenous innovation. This is partly because technology is much more likely to be appropriate to a locality if it has been developed with the involvement of local people and with accurate knowledge of local conditions. Local people may be more likely than others to be concerned with the longer term impact of technology on their community; the "externalities" of an enterprise will most likely be "internalized" in the community in due course and hence will not be excluded from cost-benefit assessments as readily as might otherwise be the case.

Another reason why the above policy commitments lead directly to the notion of endogenous innovation relates to the importance of technological skill. Innovation, especially when aimed at achieving a good technological fit, requires a great deal of human skill. If the impetus for technological innovation within a region normally stems from exogenous sources, the accumulation of relevant skills will tend to accrue outside of the region. Consequently, it would appear that neglect of endogenous innovation may institute a self-reinforcing decline in the availability of skills to adequately address local technological problems.

Economic Self-Reliance

Economic self-reliance is a theme which runs throughout the Appropriate Technology movement and which forms an important aspect of endogenous technological development.

The theme stems from an analysis of the global problematique upon which many Appropriate Technology programmes are based. Appropriate Technology has been promulgated by people who acknowledge the persistence of serious problems throughout the world - problems, for example, of social anomie, economic decay, ecological destruction and resource depletion - and who do not see these problems as likely to be resolved without conscious and concerted human action towards this end. Appropriate Technology is a response to the existence of *structural* problems in modern industrial civilization which do not

appear likely to disappear if current dominant trends continue. The growing trend towards structural interdependence between the economies of different countries, and the growing prominence of what may be termed the "world economy", creates special difficulties for local communities, local regions and their respective economies. Local communities are increasingly dependent for the health of their economies upon forces in the world economy and the economies of other regions over which they may exert very little control. The persistence of unemployment, economic stagnation, and the lack of resources to adequately confront local environmental problems in many poorer communities, has led many to question the wisdom of reliance upon exogenous economic growth and exogenous technological vitalization for the solution of local economic problems. McRobie points to this emerging attitude in the following way:[19]

> The insistence that economics and technology must spring from local culture and not dominate it runs counter to the centralist trend in all societies. Fortunately, people still object to being made the objects of nationalized production, especially if their lives are controlled by some remote and authoritarian body. This is the real pressure underlying demands for economic and political self-determination that have emerged in Scotland, Wales, Brittany, the Basque country and elsewhere - and also why, incidentally, Tasmania was the first relatively poor area of a rich country to set up an appropriate technology organization. There are, of course, many more of these 'mini-economies' than meet the eye: only a few have the political and cultural cohesion sufficient to demand more self-determination and, in more extreme cases, political separation.

For local communities and regions, economic self-reliance is an alternative to dependence upon the capricious forces of external economies. Economic self-reliance is no instant remedy for underdevelopment, but it may be more effective in the long term than passivity or complacency. Economic self-reliance may be thought of as an endogenous rather than exogenous mode of economic development.

Economic development may not be sustained without adequate access to resources. Economic self-reliance requires that, whenever practicable, greater prominence be given to the employment of local resources than exotic resources. The strategy works from the assumption that there are often substantial reserves of underutilized resources within

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19 McRobie, *Small is Possible*, p. 76.

local regions which are bypassed by dominant (normally exogenous) economic strategies; and, that these resources may frequently be mobilized for local economic development. Such resources may include: the wasted talent and labour of unemployed and underemployed people; underutilized land; waste materials; public-cum-municipal infrastructure (including buildings, capital equipment and organizations); and, local financial surpluses which may be recirculated locally with the assistance of suitable regionally-oriented banking and investment mechanisms. From the perspective of economic self-reliance, the limiting factor to local economic development may often lie more with a failure to generate the commitment and institutions to *mobilize* local resources than with a shortage of resources *per se*.

The Appropriate Technology innovation strategy is based upon the supposition that some types of technology-practice may be more suitable than others for economic self-reliance. Some technologies may be totally inappropriate for a particular community if that community is unable to obtain or cannot afford to obtain the resources necessary for the operation of those technologies.

An excellent example of this principle may be found in the joint development of a micro-hydroelectricity project by the Australian Appropriate Technology organization (APACE) and the people of a village in the Solomon Islands (Iriri, on the island of Kolombangera). Iriri, like many island villages in the Pacific region, had been suffering from social, environmental and economic decay in response to the impact of "western" cultural and economic pressures in the region. In an attempt to obtain money to, amongst other things, pay for fuel to power engines for transport and electricity generation, many Pacific islanders have allowed massive deforestation to occur on their land. A common byproduct of this strategy is the destruction of the traditional habitat and the resources it provided for the local economy; this often leads to tragic results when the viability of "selling off" timber ceases (because of reduced stock) and villagers become dependent upon imported fuel, the purchase of which they can no longer cover from their income. Iriri opted for a self-reliant approach to the development of their economy - in contrast to the practice of other Pacific island communities which turn to exogenous business ventures (often operated and owned by multinational companies).[20]

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[20] This review, covering the decade up to 1985, is based upon the following sources: private communication with Dr. R. Waddell, President, APACE, Sydney (December 1982, November 1984); private communication, J. Tutua, Co-ordinator, Western Solomons community projects (December 1982); K. Offord and P. Bryce, "Microhydroelectric Design

Iriri, with technical assistance from APACE, developed and installed a small-scale hydro-electricity system, in contrast to the usual diesel-driven systems. This provides a low-cost supply of electricity to the village (approximately 120 people and 30 houses) for lighting, coolroom and freezer facilities, recreational activities and machinery for small industries (e.g.: sawmilling, woodworking and copra drying). Iriri's economy has subsequently thrived and diversified relative to other villages in the region, and the traditional habitat has been largely maintained. Iriri has also adopted a self-reliant approach to the provision of its food supply. The village introduced an "organic" market garden based upon the use of locally available organic materials, and rejected methods which depend upon imported fertilizers and pesticides. The maintenance of the villagers' traditional habitat, made possible with the micro hydro-electricity scheme, has been an important factor enabling the organic methods to work properly. The village succeeds in meeting its own food needs and now exports a sizeable surplus in exchange for goods it cannot manufacture locally.

The economic success experienced in Iriri may not be explained exclusively by the selection of a small hydro-electricity system. It does illustrate, however, that economic self-reliance may be a workable option for local communities and that careful selection of technology which is tailored to fit the local context is a key to success. Appropriate technologies may be viewed as a means for mobilizing local resources for local economic development.

Appropriate Technology calls for self-reliance at many levels, ranging from the sub-global, at the grandest level, down through the nation, state/province, region, city and local community, to the local organization, at the local level - and even to the level of the individual person. A theme within the Appropriate Technology movement innovation strategy is that self-reliance at any one level may help reinforce self-reliance at the others. Thus, self-reliant activity by individuals within a community may help that community to become more self-reliant as a whole, and a nation comprised of self-reliant communities may in turn be more self-reliant than otherwise. Likewise, it may be argued that self-reliance amongst local communities may be an important condition for effective self-reliance by individuals, and that

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Program for Solomon Islands Village", paper presented to *E.F.Schumacher Memorial Conference on Appropriate Technology*, Macquarie University Sydney, December 1-5, 1982.

national self-reliance may be an important condition for effective self-reliance by communities within nations.[21]

As stressed in an earlier chapter, self-reliance is different to absolute self-sufficiency, the latter being a goal which very few serious writers within the Appropriate Technology movement advocate or believe practicable. For example, self-reliance in the manufacture of one product (e.g., electrical consumer goods) may require the use of production technologies which have been manufactured elsewhere. This illustrates how absolute self-sufficiency may not be a practicable policy, but it does not undermine the importance of self-reliance as a direction of striving, and does not rule out the validity of endogenous technological development as a strategy.

Community Development

A theme very closely related to economic self-reliance is that of community development. The main features of community development, as a policy objective and as an orientation for action, are: an emphasis on actual communities, particularly local communities, as the focus for development; and, an integrated approach which includes not only economics, but also cultural, social and other human factors. Appropriate Technology requires a balanced approach to community development.

Three approaches to development may be distinguished, according to the relative importance placed upon either the "bottom" or the "top" of the economy.

An approach, which may be labelled "mainstream economics", is the most widely followed of the three and is mainly concerned with the aggregate level of the economy and with such aggregate notions as Gross National Product, national inflation rate, national balance of trade, or national economic growth rates. It generally fails to account for qualitative and quantitative distinctions between local communities and assumes that what benefits the aggregate will also benefit the

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[21] W. Rybczynski (*Paper Heroes: A Review of Appropriate Technology* [Dorchester: Prism, 1980] p. 154) disputes this point; he writes: "Self-reliance at different levels simultaneously is a patent impossibility". He does not, however, substantiate his claim. Research in support of the multi-layered approach to self-reliance has been published in: J. Galtung, *Self-Reliance* [Oslo: University of Oslo, Chair in Conflict and Peace Research, 1976]; J. Galtung, P. O'Brien and R. Preiswerk, eds., *Self-Reliance: A Strategy for Development* [Geneva: Institute of Development Studies, 1980]; K. R. Hope, "Self-Reliance and Participation of the Poor in the Development Process in the Third World", *Futures*, **15**, 6 (1983), 455-462.

particular and the local. Economic policies which concentrate on the aggregate level in this way are normally oriented towards the centralized concentrations of economic power which reside with governments, large corporations or major population centers. Development, defined in narrow economic terms, is thought of as best encouraged by providing stimuli at the "top" of the economy. It is assumed that increased activity at the top or "center" of the economy will eventually "trickle down" to the "bottom" or "periphery" of the economy. This approach aims at "development-from-above" and is characteristic of the methods adopted under dominant aid programmes from the North to the South in the decades since the Second World War. Most of the literature emanating under the rubrics of the "North/South Dialogue" or the "New International Economic Order" points to the general failure of this approach. In countries of the South development-from-above has been successful mainly only for those classes or interest groups which operate at the top of the economy. Development-from-above has also tended to be the dominant approach of policy makers in the North.

An alternative approach, labelled here as the "community initiatives approach", is diametrically opposed to the one just outlined and takes as its starting point real people, organizations and communities at the local level of the economy. It rejects development-from-above in favour of "development-from-below" and an emphasis on the initiative and entrepreneurship of people at the periphery or bottom of the economy. It is based upon the view that multiplier effects, of both a narrow economic and broader socio-cultural kind, may emanate from the bottom of the economy (or society) as well as from the top. One important feature of the community initiatives approach is that it relies upon the mobilization of important biophysical and psychosocial resources from the local community level - a task for which the mainstream economics approach is not well suited. In this sense, it has value not only because of its direct benefit to classes of people normally bypassed by development-from-above, but because it enables more *efficient* use of certain underutilized resources.

The third approach may be labelled "balanced development" and is the one which most accords with the Appropriate Technology innovation strategy. Although Appropriate Technology leans towards development-from-below, its successful implementation requires the balancing of inputs from both the top and the bottom of the economy. It appears that some products and some industries of importance to a country's economic self-reliance may not be established without significant inputs from the top of the economy (e.g., alumina refining) and that some of the technologies suitable for development-from-below require

the use of materials or components which may only be available from industries at the top of the economy (e.g., high grade materials for solar energy absorption devices). Furthermore, many opportunities for the development of small industries at the bottom of the economy may rely upon a market for their products being generated by the activities of enterprises emanating from the top of the economy; this is particularly so for economies already dominated by the development-from-above approach or which lack industrial diversity.

Technological Mix

A fourth major aspect of endogenous technological development is the attainment of a good technological mix - a mix which is both suited to the circumstances of the community or region in question and which enables diversity in economic and social life.

The importance of attaining a good technological mix follows from the basic concept of the technological fit and its corollaries. The context in which technologies operate is a diverse mixture of psychosocial and biophysical factors. The notion of the technological fit may apply not only to individual technologies but also to the whole blend of technologies employed within a community: this blend should reflect the complexity of its context.

The ecological metaphors used to explain the technological fit concept may be extended here. The health and sustainability of ecosystems are viewed by ecologists as being dependent upon the maintenance of ecosystem diversity. If the diversity of an ecosystem is markedly reduced, its capacity for homeostasis is also reduced. There is a growing tendency in the literature for economics and technology-practice to be viewed in systems terms, subject to the principles of general systems.[22] To the extent that the systems of technology-practice are similar to ecological systems, it follows that cultivation and maintenance of technological diversity is a key to their stability and sustainability. Appropriate Technology is conjoint with the view that the longer-term technological and economic capacity of a community is related to the diversity of its technological base.

A good technological mix is essential to the self-reliance of communities; the capacity to draw upon a *range* of technological skills and economic activities is a key to effective local innovation. If the technological base of a community is very narrow, the ability of that commu-

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22 See, e.g., K. E. Boulding, *The World as a Total System* (London: Sage, 1985).

nity to adapt to changing circumstances may be severely limited; this is particularly true in cases where a community's economy is based primarily on a small number of primary industries and where the technology for those industries (e.g., minerals extraction industries) is not generated endogenously. If the international market for the products of those industries alters significantly, for example, the repercussions throughout the economy of that community could be devastating. A broad technological mix would provide greater opportunity for a community to absorb the loss of one of its economic activities, through either expansion of one of its other industries or the pursuit of new opportunities.

Appropriate Technology, if adopted by a community as an innovation strategy, would require that gaps in that community's technology-practice be identified and that efforts be directed towards filling those gaps with either new, locally designed technology, or by transfer of technology suited to filling those gaps from elsewhere. In either case a multifactorial technology assessment procedure would be important as a tool for optimum technology choice.

Practical Holism

Another major aspect of the integrated framework for Appropriate Technology is what may called "practical holism". By this is meant a mode of praxis based upon a holistic approach to society, the environment, technology and other factors. Such an approach avoids considering individual phenomena apart from their relationships to other phenomena and to the total environment in which they are situated. Four aspects of this theme will now be considered.

Radical Critique

One aspect of practical holism in Appropriate Technology is the radical critique which characterizes the concept and the movement. There are several ways in which the critique may be thought of as radical.

Firstly, the Appropriate Technology critique may be thought of as radical in the sense that it seeks to address the *roots* of problems rather than just symptoms. The mode of technology-practice represented by Appropriate Technology does not take the situation in question as simply "given"; i.e., the technology and its context are understood as being

open to determination by conscious human effort and as malleable over time. In each situation there may be a number of dimensions to technology-practice which might not be immediately apparent and which require critical analysis to be properly understood.

Secondly, the Appropriate Technology critique is radical in that it does not assume the *status quo* in a given set of circumstances to be either inviolable or optimum. Accordingly, it is aimed at reform of the *status quo* in cases where prevailing circumstances do not measure up well from a normative point of view. Appropriate technologies are seen as means towards reform of the *status quo* in accordance with the ideals of the movement. This reformist theme does not necessarily apply only to the whole of societies, but is directed at particular communities where reform is both needed and possible - irrespective of the need for more universal reforms. The local focus in Appropriate Technology points to the value of local reforms even if such reforms do not become widespread.

Thirdly, the Appropriate Technology critique incorporates a structural perspective. In other words, it is understood that historical events and particular examples of technology-practice are acted upon by structural forces in the society - forces which exhibit a dynamism and influence which extend far beyond the particular circumstances under consideration and which may not be significantly altered by the actions of a small number of individuals alone. The reforms which may be envisaged for a community, as part of the Appropriate Technology innovation strategy, are constrained by these structural forces, but may also be strengthened by them. The critical assessment of social structures is important to enable proper understanding of the forces of technology-practice.

Fourthly, Appropriate Technology may be seen as a response to the observation that the dynamics of the *whole* of society may influence the *parts*, and vice versa. The structural perspective just mentioned implies that actions directed at solving particular problems within a community also have implications for the community as a whole, because of the way they relate to the structures which exist in that community or within the broader society. Hence, advocates of Appropriate Technology normally have broader social and environmental objectives in mind when advocating particular appropriate technologies for particular purposes. Appropriate Technology is based upon a view of reality which portrays everything as somehow interrelated to everything else; viz., an ecological view.

The radical critique indicated by Appropriate Technology implies that technology choice at the level of local technology-practice has

important implications for structural forces which influence prospects for either reform or consolidation of the *status quo* in a community.

Human Compatibility

At the center of Schumacher's notion of Intermediate Technology, and throughout the streams of the Appropriate Technology movement surveyed earlier, may be found a *conscious concern for people*. In Chapters Four and Five it was demonstrated that, for Schumacher, this is much more than a platitude: it is an explicit policy focus which is translated into operational guidelines for economic development and technological innovation. Thus, the content of technology-practice ought to embody in a tangible way the characteristics of the human context in which it is intended to operate.

Appropriate Technology implies that human ends and technological means may not be randomly combined. Technological means may not properly serve given human ends unless they incorporate, in their constitution, qualities or features which are adequate for those ends. Technological means are not infinitely malleable vis-a-vis human ends. This understanding of means and ends is reflected in the use of the phrase "technology with a human face" by Schumacher and others as a general rubric for Appropriate Technology. The phrase fulfils a useful rhetorical function but it also does more than that: it expresses the basic principle of Appropriate Technology that technology ought to *fit* its context. The notion of the psychosocial and biophysical context which forms part of our technological fit concept implies that technologies ought to be compatible with their *human* context.

It is beyond the scope of this study to fully examine the nature of the human context referred to here. Such a task would require a comprehensive survey of all humanities and social science disciplines. The operational criteria adopted as part of the Appropriate Technology innovation strategy would be dependent upon the assessment of the human context made by each group of decision makers. Different schools of thought would probably adopt different criteria. The difficulty involved in making an assessment of the nature of the human context, at both the universal and particular level, does not *ipso facto* invalidate the requirement that such an assessment be made. Rather, it places the onus on each group of decision makers to make such an assessment for themselves. The difficulty of the task, and the fact that different groups of people may arrive at a different assessment of the circumstances and principles at stake, does not mean that the task is impossi-

ble or that consensus amongst groups of decision makers may not be achieved. It is quite possible for people within a local community to achieve some consensus, through political or other media, on some basic human concerns - without going through the process of comprehensive and rigorous scholarship. Within scholarship, furthermore, the existence of schools of thought indicates that some kind of cogent assessment of the human context is possible - even if schools of thought vary between each other. The practicability of the Appropriate Technology innovation strategy within a given community will be limited by the capacity for the technological decision makers of that community to achieve some basic assessment of the human context of that community.[23]

The human context of technology includes not only those objective factors which may be described in a straightforward empirical manner, but also the subjective preferences of people. To speak of technology being compatible with its human context therefore means that the technology must be adequate from the perspective of human subjectivity. These comments are not meant to imply that subjectivity and objectivity are mutually exclusive, but rather that *both* subjective *and* objective considerations are raised by the technological fit concept.

The difficulty of ensuring that technologies are humanly compatible does not appear to have prevented the Appropriate Technology movement from articulating certain basic principles for guiding technology assessment and technological innovation. The fact that an emerging consensus may be identified in the movement is evidence that the complexities of the human context are not necessarily beyond the comprehension of most people; and, that achieving human compatibility of technology is not necessarily beyond the resources of most communities. On this point Schumacher writes:[24]

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[23] An attempt to systematically apply considerations of the human context of science and technology for policy purposes has been conducted by the Canadian Government under the auspices of its Social Sciences and Humanities Research Council. The programme, directed by C. A. Hooker, illustrates how serious interdisciplinary work may provide a practical framework for the application of the "human compatibility" principle discussed here (see: C. A. Hooker, et al., *The Human Context for Science and Technology* [Ottawa: Canadian Social Sciences and Humanities Research Council, 1980]; C. A. Hooker, "Science, Technology and Australian Society: Shall We Follow the Lead of Our Cousins?", *Search*, **16**, 5/6 (1985), 126-127.

[24] E. F. Schumacher, *Small is Beautiful: A Study of Economics as if People Mattered* (London: Blond and Briggs, 1973), p. 149.

> No doubt, a price has to be paid for anything worth while: to redirect technology so that it serves man instead of destroying him requires primarily an effort of the imagination and an abandonment of fear.

The impact to date of the Appropriate Technology movement appears to stem substantially from the belief that, despite the obstacles, technology may be directed towards being humanly compatible.

Human compatibility involves both psychosocial compatibility and biophysical compatibility.

The biophysical health of people depends greatly upon the quality of the environment in which they live and upon which they depend for food and other essential inputs and for the processing of their wastes. The impact of technology upon the environment is therefore a potentially significant influence on human health. The environmental compatibility and the human compatibility of technology appear to be closely related. The biophysical aspects are important not only because of *indirect* human impacts mediated by the environment. The use of technologies in the home, in recreation and in the workplace, can have *direct* biophysical impacts on people (e.g., the absorption of household chemicals such as pesticides into the body, the development of unhealthy posture through use of industrial technology, or the development of repetitive strain injury through use of office or workshop technology). In humanly compatible technology the direct biophysical impacts of technology upon people are "acceptable" or benign.

The dominant aspect of human compatibility addressed by the Appropriate Technology movement concerns the capacity of technology to meet the psychosocial needs of human beings. The issue receives its fullest treatment in the movement's discussion of *work*. It is held almost universally throughout the movement that appropriate technologies ought to enable the *provision* of worthwhile work. This involves the provision of work opportunities for all people and the requirement that the *quality* of the work be such as to make it humanly worthwhile. This theme within the movement may not be derived solely from the general-principles concept of Appropriate Technology. The movement's discussion of work and technology involves the *advocacy* of certain normative purposes for human life and the evaluation of the status of work in terms of those purposes. The prime normative principle here is that work is considered to be a desirable human activity rather than a "necessary evil". Thus, for the Appropriate Technology movement, work (of a suitable kind) is considered to be both an end and a means: *technology ought to be a means of enhancing work and not a substitute for work*. This is not to say that all types of work carried out

by people in a given community are intrinsically good and that work ought not to be altered by the introduction of new technology, but that, in the final instance, adequate work opportunities ought to be made available to all people and that the quality of the work experience ought to be heightened.

The approach to work adopted by the Appropriate Technology movement, and as contained in our synthesis of Appropriate Technology, draws upon the broader social vision of the movement. The movement places supreme importance on the attainment of general social wellbeing, spiritual-cum-cultural vitality and political freedom for individuals and communities - through structures which do not preclude the attainment of these goals by some people as a necessary precondition or consequence of their attainment by others. Such an ideal is not new and may be found repeatedly throughout Western intellectual history and political movements. A distinctive feature of Appropriate Technology is the claim that the pursuit of this ideal has tangible implications for the form of technology-practice adopted. This is recognized by Winner who argues that, at its most ambitious level, Appropriate Technology means setting the whole question of technology choice in the context of a theoretical understanding of what an emancipated society would look like.[25] In this respect, however, the movement is not without precedents. Winner writes:[26]

> … alternative technologists have revived a project which had been abandoned with the eclipse of 19th-century utopianism: the work of proposing a clear and systematic notion of the good life that can be translated into principles and criteria of institutional design.

Appropriate Technology requires the conscious articulation of design principles to ensure that technology-practice does not in fact frustrate the human ends which it ostensibly serves as means.

Environmental Compatibility

Parallel arguments to those just presented in relation to human compatibility may be applied to the environmental compatibility of

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25 L. Winner, "The Political Philosophy of Alternative Technology: Historical Roots and Present Prospects", *Technology in Society*, **1**, 1, 80-82.

26 *Ibid*., p. 81. Note: Winner's use of "alternative technologists" is equivalent to the use of "proponents of Appropriate Technology" in this book.

technologies, recognizing that the latter may often be a precondition of the former.

Pointing to the need for technologies to be compatible with the environment (i.e., the biosphere and the biophysical context of human settlements) is at one level no more than a recognition of the functional requirements of sustainable biophysical systems; viz., the maintenance of the biophysical environment in which a technology is to operate requires that the technology's operation does not violate that environmental system beyond a point where it will no longer be viable. For example, if the use of agricultural technologies and concomitant management practices leads to excessive deforestation, soil erosion, destruction of soil micro-organisms and rising salt levels, that land in question may no longer be suitable for agricultural purposes and, therefore, the continued use of that technology.

At another level, however, the objective of environmental compatibility embodies normative goals. The collapse of a biophysical system might be accorded very little significance apart from the implications it holds for human society. If one does not place intrinsic value on the maintenance of biological diversity (or recognize its value - depending upon one's ethical philosophy) the *collapse* of a biophysical system might be considered, with equal justification, simply as a transformation towards a different system. Given that natural biophysical systems may not be viewed as static, the existence of technology-induced change is by itself of no great significance. The notion that technologies ought to be environmentally compatible implies that some form of *evaluation* of the biophysical environment is required - in terms of its possible instrumental, intrinsic or transcendental significance.

If it is assumed that the biophysical system which forms the context for technology-practice ought to be sustained (as a dynamic system), and if it is assumed that technology-practice does have environmental implications, then it follows that technologies ought to be made environmentally compatible. These suppositions are rather obvious and are not likely to be disputed. The Appropriate Technology movement's critique of the status quo, however, reveals its judgement that mainstream technology-practice is not grounded sufficiently in a recognition of these suppositions. The principles of Appropriate Technology require special and concerted attention - despite their seemingly common sense nature - precisely because modern technology-practice does not appear to effectively incorporate such common sense.

Schumacher offers a partial explanation for how such a gap could occur between common sense and common practice:[27]

> … the changes of the last twenty-five years, both in the quantity and in the quality of man's industrial processes, have produced an entirely new situation - a situation resulting not from our failures but from what we thought were our greatest successes. And this has come so suddenly that we hardly noticed the fact that we were very rapidly using up a certain kind of irreplaceable capital asset, namely the tolerance margins which benign nature always provides.

According to Schumacher the scale and impact of human technology-practice, until very recently, was generally limited in relation to the carrying capacity of the environment. The seemingly exponential growth during this century of industrial activity, and associated factors such as energy usage and population growth, has brought the impact of human civilization close to the point where many of the homeostatic processes of the natural environment cease to operate properly. The harmful impact of environmentally "incompatible" technologies may have been tolerable when their magnitude was relatively small in relation to local ecosystems and the biosphere as a whole.[28] This may have made it easier for modern technological society to evolve in a mood of corporate indifference to what now appears common sense. Appropriate Technology represents a critical response to the dangers of a society being dependent upon a mode of technology-practice which tends to undermine the environment upon which that society ultimately depends.

The following practical principles accord with the environmental compatibility requirement of Appropriate Technology: that available natural resources be utilized as efficiently as possible, minimizing waste; that waste products be re-used and recycled as much as possible; that maximum use be made of locally available resources, with technology being tailored to match those resources; that local and distant environmental impact be minimized where possible, with technology-practice taking full account of ecological principles and local ecosys-

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[27] Schumacher, *Small is Beautiful*, p. 15.

[28] This theme does not warrant extensive discussion here. Basic evidence for the argument has been assembled elsewhere (e.g.: D. L. Meadows, et al., *Dynamics of Growth in a Finite World* [Cambridge, Mass.: Wright-Allen, Inc., 1974]; A. H. Ehrlich, P. R. Ehrlich and J. R. Holdren, *Ecoscience: Population, Resources and Environment* [San Francisco: Freeman, 1977]; P. R. Ehrlich and A. H. Ehrlich, *Extinction: The Causes and Consequences of the Disappearance of Species* [New York: Random House, 1981].

tems; that renewable resource supplies be used wherever possible; and that a transition to a low-pollution, renewable-resource economy be pursued diligently.

A distinctive feature of the Appropriate Technology innovation strategy is that it emphasizes the role of local technology-practice as a key to the solution of global environmental problems. This is based upon the view that a reduction in local environmental damage is necessary for a reduction in global environmental problems, which are often exacerbated by the compound effects of locally produced pollutants. Evidence is mounting that the adoption of environmentally benign technology-practice at the local level may be pursued without weakening economic progress.[29]

Integrated Problem Solving

A final feature of the Appropriate Technology innovation strategy is the integrated approach to problem solving which it embodies. This incorporates two dimensions.

The first dimension to integrated problem solving is the adoption of a *systems approach* to analyzing phenomena, understanding problems and designing practical solutions. This is implied by the foregoing discussion. The systems approach is based upon the general principle that phenomena do not exist in isolation but as part of larger systems which exhibit internal dynamics of their own and which interact in a dynamic way with other systems. According to this principle a reductionistic and atomistic form of analysis is incapable of providing a comprehensive and fully reliable explanation of phenomena. The internal dynamics of individual systems (which, in the "real world", may normally be taken to be open systems) are affected by their relationship to other systems. The interaction of systems or subsystems may lead to results which could not have occurred had those systems existed in isolation.

Systems theory can become very formal and abstract, and seemingly distant from the complexities of the real world. Appropriate Technology, however, is an example of how the theory may be applied in a practical way. At its most basic level it means that technology choice must be based upon an assessment of the main factors in the oper-

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[29] See: W. U. Chandler, *Energy Productivity: Key to Environmental Protection and Economic Progress*, Worldwatch Paper #63 (Washington, D.C.: Worldwatch Institute, 1985); H. E. Daly, "Introduction to the Steady-State Economy", in *Economics, Ecology, Ethics: Essays Toward a Steady-State Economy*, ed. by H. E. Daly (San Francisco: Freeman, 1980), pp. 1-31.

ating environment of technology which will affect how that technology operates, and the main effects upon that environment which are likely to occur. The systems approach means that indirect as well as direct impacts ought to be considered. For example, by applying a systems analysis to four different methods of rice cultivation in the Third World setting, with a special focus on thermodynamic and cultural factors, Freedman has provided forceful evidence for the productive superiority of a new alternative to either traditional labour-intensive methods and the modern "green revolution" methods.[30] Another example of the application of systems oriented research may be found in the work of the New Alchemy Institute, a Massachusetts based Appropriate Technology group. The Institute has applied advanced biological science to the development of an integrated horticulture/agriculture/space-heating system for cold climates, incorporating the use of solar absorption and wind technologies for energy supply.[31]

The second dimension to integrated problem solving in Appropriate Technology is what may be called the *strategy of simultaneous problem solving*. This strategy is based upon the recognition that problems from ostensibly unrelated fields (e.g., energy policy and employment policy) may in fact be closely related, and that the appropriate technological response to one problem might be related to the appropriate response to another. A single technology or, strictly speaking, a single package (or system) of technology-practice, may *simultaneously* solve more than one problem. The Appropriate Technology innovation strategy aims to implement systems of technological means which deliberately serve a range of human ends *simultaneously*.

This theme is most apparent in the literature and programmes which are promulgated under the rubrics of "community development" and "local self-reliance". The local community level provides a nexus for most of the issues and factors outlined so far in this study. The local community or region provides a high enough level of aggregation for the major dynamics of culture, political-economy, people-environment interaction and technology-society interaction, to become apparent. It also provides a low enough level of aggregation for the "real life" content of these dynamics (or structures) to exhibit a comprehensible mean-

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30 S. Freedman, "Agricultural Development in the Less Developed World: Energy Limitations and Planning Strategies", in *Technology Choice and Change in Developing Countries: Internal and External Constraints*, ed. by B. G. Lucas and S. Freedman (Dublin: Tycooly, 1983), pp. 143-155.

31 T. Cashman, "The New Alchemy Institute: Small-Scale Ecosystem Farming", *Appropriate Technology*, **2**, 2 (1975), 20-22..

ing against which local people may respond. When only high levels of regional aggregation are considered, it is difficult to identify effective strategies for dealing with local dynamics intertwined with national and international structures. Within the Appropriate Technology movement, action at the local community level is rarely viewed as a substitute for action addressed to solving structural-cum-political problems at a higher level of aggregation; it is viewed as a complement to the latter and as a realistic medium through which actual individuals may make a meaningful contribution to political and economic life.

A good example from the Appropriate Technology movement of simultaneous problem solving is the promotion of "humanly scaled energy systems" and "energy efficient community planning". Through a judicious combination of technology choice, community planning, responsive government action, life-style management, and entrepreneurship, it is possible to simultaneously reduce pollution, recycle waste, conserve energy, create new employment opportunities, vitalize local business activity, save money and develop greater community cohesiveness.[32] A second example is the Intermediate Technology approach to economic development advocated by Schumacher. The synthesis of Schumacher's work in Chapters Four and Five shows that Intermediate Technology is an integrated strategy for the simultaneous solution of the six major components of the "development problematique". Schumacher's analysis of the vicious circle of problems which constitute underdevelopment is based upon the systems approach.

The combination of systems thinking and the simultaneous problem solving strategy leads to an integrated assessment of human and environmental problems. For the Appropriate Technology movement, human problems and environmental problems may not readily be separated, if at all. A distinguishing feature of the emerging consensus in Appropriate Technology, and a principle which is contained in the concept of the technological fit, is that technologies ought to be simultaneously humanly compatible and environmentally compatible.

The integrated problem solving which is part of Appropriate Technology opens up a wide scope of resources for problem solving. Mainstream approaches to economic development and technological development which ignore the importance of systems and multifacto-

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[32] See, e.g.: D. Morris, *Self-Reliant Cities: Energy and the Transformation of Urban America* (San Francisco: Sierra Club Books, 1982); J. Ridgeway and C. S. Projansky, *Energy-Efficient Community Planning* (Emmaus, PA: The JG Press, n.d. [1980?]) Note: George McRobie's survey of the Appropriate Technology movement in the North places great emphasis on local, community based initiatives which serve several purposes at once (cf., McRobie, *Small is Possible*, esp. pp. 86-191, 247-280).

rial approaches to technology choice, in favour of simplistic and unidimensional approaches, may fail to acknowledge and utilize all available resources for the development and maintenance of local communities.

For example, when faced with a situation where effective demand within a community for electricity outstrips available supply, engineers in a public utility not sympathetic to Appropriate Technology may look at the problem as one of how to generate higher absolute amounts of electricity. If substantial new installations were required for this purpose and if the availability of local capital for investment was low, combined with a relatively high cost of credit, that community's energy problems might either remain unsolved or be solved at the price of redirecting financial resources away from some other area of concern to the community (such as education). Adopting a wider view, in contrast, could reveal the potential for conservation as a cost-effective means for resolving the community's energy supply problems.[33] This would involve the adoption of a range of technologies more suited to energy efficiency for domestic, industrial and other purposes; it would also involve greater participation by people, in their capacity as citizens or as professional officers, in producing, installing and using new technologies, and in making decisions and plans regarding lifestyle and management practices. It might also involve an increase in the use of alternative sources of energy requiring alternative technologies to those already in use. The important point here is that the conservation approach would draw upon a range of human resources irrelevant to the narrower approach. From the point of view of an engineer experienced only with the mainstream energy-supply technologies, reliance upon increased use of *human* resources may appear unattractive. From the point of view of integrated community development, however, the mobilization of possibly underutilized human resources with the concomitant stimulus this would provide throughout the community, may appear very attractive. The arguments for the latter option could be even more compelling for communities with high unemployment levels.

The conservation oriented approach also has the advantage that, because it aims to serve more than energy-supply objectives alone (e.g., provision of community welfare services, employment training and employment generation, environmental protection, improvement of building stock, and environmental education), it may be integrated with other community programs and draw upon resources (people, waste

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[33] Cf., section on "Energy Pathways" in Chapter Seven.

materials, infrastructure, money, etc.) which would otherwise not be available for addressing energy policy problems.

The integrated problem solving approach which characterizes Appropriate Technology may reveal new possibilities for community development which are affordable because of the emphasis upon mobilizing underutilized community resources which would not be relevant to the more simplistic mainstream approaches.

The term "practical holism" has been coined to denote the approach which combines radical criticism and integrated problem solving with concern for the human and environmental compatibility of technologies. It denotes not only holistic ways of understanding reality, but a mode of praxis which incorporates holistic analysis and an integrated package of complementary activities.

In contrast to the critiques of the technological society which portray the imperatives of technology, the requirements of environmental conservation and the needs of humanity as being in some kind of intrinsic conflict, Appropriate Technology points to the possibility of these three factors being harmonized, but on the condition that technology is chosen judiciously in accordance with the principles of the technological fit, endogenous technological development and practical holism.

Conceptual Clarification

Before proceeding further, certain concepts contained herein deserve further clarification.

Misconceptions

Repeated reference has been made to the notions of *mainstream technology*, *alternative technology* and *appropriate technology*. It is not uncommon for these three notions to be confused and misinterpreted.

The misdirected view, which appears to predispose some people against serious consideration of Appropriate Technology, begins with a simplistic distinction between "mainstream technology" and "alternative technology" and assumes that these categories are mutually exclusive. Thus, a technology is depicted as either mainstream or alternative, but not as a combination of both.

It is also assumed that "mainstream technologies" are by nature superior from the point of view of efficiency and are the quintessence of modernity. "Alternative technologies", in contrast, are assumed to be

inherently inefficient, and based upon outmoded knowledge and practice. It is common for "mainstream technologies" to be lauded as "high" and for "alternative technologies" to be dubbed "low".

When stated explicitly in this manner this "misdirected" view appears untenable; nevertheless, the attitudes which it embodies are quite widespread. The extremely simplistic nature of this view is generally not apparent to its adherents because it is not normally articulated explicitly. It normally takes the form of a tacit perspective which is only revealed indirectly through policy decisions, action programmes and incidental discussion about technological matters. Occasionally such views, which normally remain tacit, are expressed openly in published literature; this is illustrated by the following quote from a paper by an urban physical planner:[34]

> There is some talk, which seems to have some standing as an intellectual 'fashion', about abstaining from the use of new 'hard' technology in favour of a retreat to earlier technologies or of inventing alternative ones. This fashion attracts followers who try personally to realize such 'escapist' attitudes, but it is scarcely applicable as a solution for society as a whole. It is almost impossible to induce people to produce *less* for the same input of labour and capital, or to spend *more time* to reach the same destination, or even to abstain voluntarily from some comfort which makes life 'easier' when it is offered by modern 'hard' technology.

It is important to raise these misconceptions explicitly because, by remaining as tacit views, they appear to be a major obstacle to bridging the gap discussed earlier between common sense and common practice.

By tacitly assuming that a dichotomy exists between the two modes of technology practice ("alternative" and "mainstream") adherents of the misdirected view tend to automatically equate "appropriate technology" with "alternative technology". The term "appropriate technology" consequently connotes a type of technology-practice incompatible with the mainstream, and appropriate technologies (when labelled as such) are therefore assumed to be "low", "outmoded", "inefficient" and therefore not worthy of serious consideration. The misdirected view leads to the ironic situation where the term "appropriate tech-

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34 E. Brutzkus, "Technological Advance Beyond the Optimum", *Ekistics*, **284** [Sept/Oct 1980], 385). An ironic feature of the paper by Brutzkus is that, despite his disparaging remarks, the substantive position he adopts is remarkably similar to that advocated by the Appropriate Technology movement as a whole.

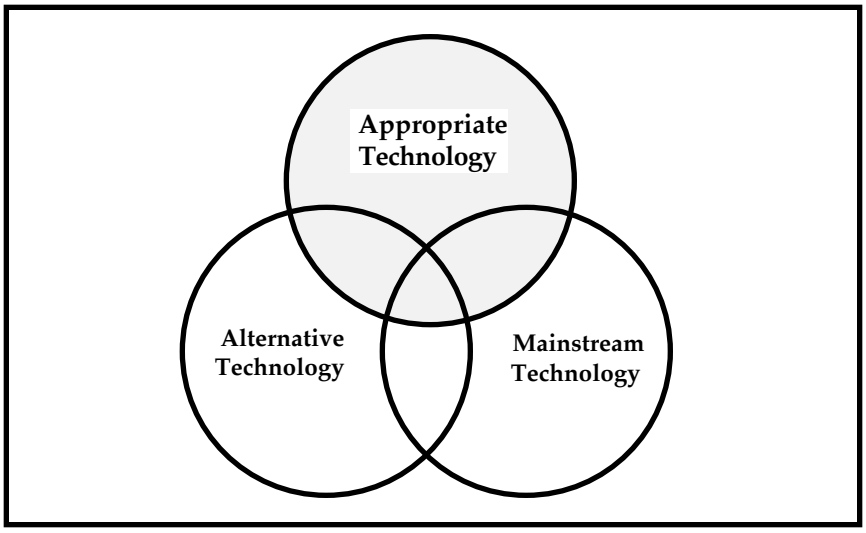
nology" is used to describe technologies which by definition would have little chance of qualifying as appropriate.

Preferred View

The view of Appropriate Technology adopted herein rejects the assumption that technology-practice may be divided into two discrete modes, "alternative technology" and "mainstream technology". The preferred view is portrayed in Figure 10.2. Alternative Technology, Mainstream Technology and Appropriate Technology are taken to be three overlapping categories of technology-practice. Appropriate technologies may include technologies from the mainstream, alternative technologies and a range of new technologies required to fit contexts for which accepted alternative and mainstream technologies are inadequate.

Thus Appropriate Technology is not predisposed towards "low", "inefficient", "old fashioned" or "unpopular" technologies, on one hand, or "high", "efficient", "modern" or "popular", on the other hand - although, where efficiency is defined in broad, systems terms, Appropriate Technology is by definition concerned with the attainment of maximum efficiency.

Figure 10.2 *Preferred View of Appropriate Technology*



In summary, our critique of the Appropriate Technology movement and its literature leads to a view of Appropriate Technology as a mode of technology-practice rather than a particular collection of artefacts. Although proponents of Appropriate Technology have shown more of an interest in some fields rather than others, it is a mode of technology-practice applicable to most, if not all, fields.[35] It is primarily an innovation strategy aimed at achieving a good fit between technologies and the contexts in which they are intended to operate. This strategy also aims at endogenous technological development within local communities and regions, and depends upon the adoption by technological decision makers and the communities in question of holistic modes of praxis.

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[35] In addition to the fields addressed in earlier chapters, there is an increasing tendency for the rationale of Appropriate Technology to be applied to new or emerging fields such as information technology (see, e.g., M. Elmandjra, et al., *Informatics: Is There a Choice?*, special edition of *Development: Journal of the Society for International Development*, **1** [1985], 1-85).