AN APPROPRIATE TECHNOLOGY CHECKLIST[1]*

Charles C. Verharen (Corresponding Author)
Department of Philosophy, Locke Hall 226, Howard University, Washington, DC
cverharen@howard.edu, 202-806-6811
John Tharakan
Department of Chemical Engineering, Howard University
jtharakan@howard.edu, 202-806-4811

Abstract

The protocol for the International Network on Appropriate Technology (INAT) defines the objectives and methods of globally sustainable and equitable technology. This essay provides a checklist for INAT members to use in assessing the merits of proposed technologies. Checklist items serve as reminders of steps to be taken while engaged in life-critical measures. The checklist focuses on three aspects of proposed projects: their rationality, ethicality, and compatibility with key features of appropriate technology. Justification for the first two sets of checklist items flows from the origins of rationality and ethicality in evolutionary processes. The rationale for the last set evolves from historical applications of appropriate technology.

Key Words: Ethics, rationality, appropriate technology, checklist

INTRODUCTION

The protocol for the International Network on Appropriate Technology (INAT) defines the objectives and methods of globally sustainable and equitable technology. This essay provides a checklist for INAT members to use in assessing the merits of proposed technologies.

The checklist model derives historically from aviation (Turner 2001) and more recently from hospital practice (Provonost 2010, Gawande 2009). Checklist items serve as reminders of steps to be taken while engaged in life-critical measures. Two points are key in using checklists. First, careful use of the checklist does not always guarantee successful outcomes. The items must be applied in the context of collective professional practices. Second, correct use of the checklist items is a matter for professional judgment rather than algorithmic rule application.

In the context of the INAT protocol, not only scientists and engineers but also social scientists, ethicists and members of the communities in which appropriate technologies are to be deployed should use the checklist for collective decisions. Where practical, social science professionals should include economists, political scientists, psychologists,

[1] As appeared in *Proc. 4th International Conference on Appropriate Technology: Appropriate Technology for Water and Sanitation: Solutions for a Thirsty, Polluted Planet, Accra, Ghana, November 2010,* Dzidzeniyo et al (eds), KNUST Press, Kumasi, Ghana; ISBN 978-1-60725-560-4, Nov. 2010.

anthropologists, sociologists, and social workers. Physical science specializations will vary according to the nature and environmental context of potential projects, but at the very least biologists, chemists, physicists, and environmental (including earth and atmosphere) scientists should be on call. Participation of ethicists with field experience is critical.

The checklist focuses on three aspects of proposed projects: their rationality, ethicality, and compatibility with key features of appropriate technology. Justification for the first two sets of checklist items flows from the origins of rationality and ethicality in evolutionary processes. The rationale for the last set evolves from historical applications of appropriate technology.

Rationality

Defining *rationality* is the first step in constructing a checklist. Rationality is our capacity to select and carry out our goals. Before rationality became self-conscious or reflexive, goal selection and execution were automated processes. Goals unencumbered by humanity's capacity to construct mythical goals were survival and flourishing, set within the limits of the environment. Humans share these goals with other organisms.

Because our large brains have given us the capacity for massive abstraction and imagination, we can now change the environment to suit our goals in ways that other animals do not. Our rationality now includes not only goal selection but the capacity to alter "naturally ordained" goals through rationality's reflexive function.

Like language (see Chomsky 2000) and morality (see Hauser 2006), rationality is both genetically and culturally endowed. As humans are capable of speech and moral behavior, so they are also capable of expressing rationality in the form of science. Here I use *science* in the sense of abstracting from experience to form guiding generalizations. (*Experience* includes mental as well as sensory phenomena—even the most theoretical mathematics is, after all, an experience.) As those generalizations begin to conform more precisely to the constraints of rationality itself, science begins to take on its modern mathematical form.

Rationality's constraints follow from its evolutionary function. The complex brain and its capacity for imagination and abstract thought augment our capacity for survival. A brain mapping and basing its behavior on selected patterns in its environment has a better chance of survival than an organism that reacts "blindly" to its circumstances through chemical signals or purely automated stimulus-response mechanisms.

Humans are gifted with the ability to externalize their mapping functions through the use of symbols. Symbols express their own survival capacities by triggering emotional responses that move us to replicate them—the memetic process. Symbols have emotional as well as semantic and syntactic meaning. We select symbol sets, theories, in part by reason of their capacity accurately to reflect our experience. Culture, education, and other experiences shape our rationality.

RATIONALITY CHECKLIST

ITEM 1: SEMANTIC AND EMOTIVE MEANINGFULNESS

We are prompted to ensure the emotive, semantic, and syntactic force of the symbols we use to "re-present" experience (the first presentation was through the senses). Symbols used to present candidates for appropriate technology must in their net effect be emotionally compelling. Their semantic meanings, the networks of relations that tie them to experience, must be clearly understood. The ambiguity of symbols flows from their very etymology: "sym-bols" are literally "throwings together." Symbols acquire their meanings through (initial) acts of choice. The nature and limits of choices of symbols must be continually reviewed.

ITEM 2: CORRESPONDENCE BETWEEN A TECHNOLOGY'S THEORETICAL ASPECTS AND ITS TESTED RESULTS

Every proposal for an appropriate technology is conveyed through symbols, whether they are elements of ordinary spoken language or graphic representations such as blueprints. Those symbolic representations of a technology and its predicted consequences must be carefully mapped onto experience. The correlation of symbolic representation and experience is enshrined in what is called the correspondence theory of truth. One of the primary functions of the brain is to establish correlations between its states and those of the environment.

ITEM 3: NON-CONTRADICTORY CHARACTER OF A TECHNOLOGY'S THEORETICAL ELEMENTS

A third prompting insists that theoretical proposals for appropriate technology cannot offer contradictory representations of experience. The primary instrument of rationality is reason. Reasoning most simply defined is the process of connecting experiences by means of abstract patterns. It would be "irrational" to claim that a thing "x" is connected to something else "y," and at the same time in the same way is not connected. This "law" of non-contradiction is so important in the history of thought that it serves as the foundation of the coherence theory of truth.

ITEM 4: PRACTICALITY OR EFFECTIVENESS OF A TECHNOLOGY

A technology that cannot execute the purposes for which it is designed is an unacceptable project. Thinking itself has evolved by reason of its practical nature. The practicality of proposed projects is enshrined in the pragmatic theory of truth. This theory holds that it is never possible to know the truth in any absolute way. The best we can achieve is to hold beliefs that yield the consequences we aim to achieve.

ITEM 5: WIDEST POSSIBLE APPLICATION OF A TECHNOLOGY

A fifth prompting demands that proposals for appropriate technology have the widest possible application. A technology that can perform multiple functions is to be favored over one that can execute a single function, other things being equal. This prompting follows from the conviction that our theories or technical proposals should cover the

widest possible range of experience. The evolution of computers from calculating machines to multi-tasking devices is an example of this principle in action.

ITEM 6: SIMPLICITY OR ECONOMY OF A TECHNOLOGY: "DOING THE MOST WITH THE LEAST"

A sixth prompting is the truest test of the intellectual power of a technology proposal: KISS, or Keep It Simple, Solomon. An engineer who can streamline a device so its every part is indispensable to its function is simply a genius. Thinking is itself the art of abstraction. Abstraction in its original sense is literally a "pulling apart" of a pattern from an experience. The simpler the pattern, the higher its degree of abstraction. The test of a pattern's simplicity is the number of symbols required for its representation. The fewer symbols required for a proposal's representation of experience, the more abstract the proposal.

ITEM 7: A TECHNOLOGY'S CAPACITY TO STIMULATE REEXAMINATION

The seventh and final prompting springs from the conviction that no matter how good a technology is, there must be some way to improve on it. Technologies that by their very nature induce us to rethink the ways we think exemplify this checklist item.

APPLYING THE CHECKLIST: RULES NOT INCLUDED!

None of the seven items on the rationality checklist are "make or break" items Compliance with checklist items cannot guarantee a technology's "perfect" rationality.

For example, the theories underpinning a technology may be false, even if the technology itself works perfectly well. A proposal to drain a swamp to stop malaria's spread might follow from the hypothesis that "bad air" (the roots of the term *mal-aria*) is the cause of the disease. If the swamp is in fact the exclusive breeding ground of the anopheles mosquito, the technology would be practical. But the underlying theory would be false.

Rationality is a function of connectivity. The rationality of a technology can be measured by the numbers and kinds of connections that issue from its guiding principles. A technology may fit several items on the checklist and fail utterly on others. The items are intended as reminders rather than as strict rules for a technology's compliance. Particular evaluation metrics may not be pertinent in some cultural contexts and applications. (Tharakan *et al*. 2005).

ETHICALITY

Ethicality first requires its own definition. *Ethics* has acquired the sense of a field distinct from morals. *Morals* refers to behavior that is customary or acceptable in a given society. *Ethics* means the study of morals and more deeply the study of value itself. What is valuable is what is desired or, more strictly, what is desirable given some set of fundamental assumptions.

At its most basic level, ethics considers appropriate mechanisms for choosing principles or values to guide our lives. Rationality and ethicality are analogous in the sense that both are complex phenomena that cannot be given a single-factor analysis. Both are indispensable for choosing the directions of our lives. We draw an analogy between tests for rationality and ethicality. Just as rationality cannot have a single defining criterion, so ethicality is expressed through a basket of values.

Philosophers like Plato, Aristotle, and Kant have exaggerated rationality's importance, declaring it to be the primary human value. However, rationality itself depends on our survival for its exercise. Pleasure also drives us toward survival, as do love, caring, and community bonding in our lives. Freedom, happiness, and meditation as well are close allies of survival. Nevertheless, survival cannot be given a role as the preeminent value because many humans whom we respect and cherish over the ages have sacrificed their own survival for the sake of values they deemed more important than survival—love in the case of Christ, duty for Socrates, *satyagraha* for Gandhi.

ITEM 1: SURVIVAL
Does the proposed technology promote the survival of those for whom it is intended? Over the past five thousand years of recorded human experience, no debate has been more contentious than the question of an ultimate value: does some single value serve as the foundation for all other values? The most brilliant philosophers have proposed a wide range of answers to that question. One fact overrides all ethical controversy: to be good is first of all to be. Unless we exist, unless we survive, all reflection on value is impossible.

ITEM 2: FLOURISHING OR HAPPINESS
Does the proposed technology promote the flourishing of those for whom it is intended? The concept of "flourishing" takes its meaning from biology. We speak of organisms as flourishing if their basic needs beyond mere survival are met. The conditions for basic human survival are air, temperature control, hydration, nutrition, health care, and education. Given the prospect of global climate change, we must deploy technologies that are additive with respect to the environment (cf. the cradle to cradle configuration of industrial ecology, McDonough and Braungart 2002.)

ITEM 3: RATIONALITY
Does the proposed technology execute the seven checklist items for rationality in the most appropriate ways? From the vantage point of evolution, rationality is the instrument that has driven the human population from a handful 200,000 years ago to nearly 7 billion strong today.

ITEM 4: COMMUNITY SOLIDARITY
Does the proposed technology promote community solidarity in the best possible ways? Philosophers like Mo-Ti and Christ in East and West Asia have claimed that love or the bonding power of any community whether large or small is the primary human objective. From an evolutionary viewpoint, humans are incapable of surviving without community support.

ITEM 5: FREEDOM OR CREATIVITY
Does a proposed technology enhance the freedom of the communities in which it is to be deployed? Here we use the term *freedom* to mean "freedom of choice." We have choices because of our rationality, our power to abstract from unique experiences to form generalizations. Generalizations allow us to predict and thereby control the future. From an evolutionary point of view, freedom as the ability to create variation in our lives is a primary guarantee of our survival.

ITEM 6: PLEASURE
Does a proposed technology enhance the pleasure of the communities in which it is to be deployed? We can give an evolutionary explanation of pleasure by saying it is the driving mechanism that points us in the direction of the behaviors necessary for the survival of the species.

ITEM 7: MEDITATION OR CONTEMPLATION
Does a proposed technology enhance the capacity of its users to think about their thinking? Central and East Asian cultures affirm that meditation is a primary value. Meditation is perhaps best defined as the control of the attention by the attention. Our survival depends on paying attention to the right thing at the right time. Organisms that can control their attention through rational reflection can exert some measure of control over their survival

APPLYING THE CHECKLIST: CAN ETHICAL VALUES BE RANKED?

The separate checklist values have their champions in the history of philosophy. Each great philosophical tradition makes a case for a single value's having overriding status. Can these disparate values be ranked or does each hold an independent status, as is the case with the basket of values comprising rationality? Survival may under certain circumstances trump all other values—particularly for communities or for the whole earth population when survival is at risk

APPROPRIATE TECHNOLOGY EVALUATION AND IMPACT ASSESSMENT

Appropriate technology has been a contentious issue since Schumaker (1989) decried mega-projects as the only route to improving the quality of life in the "third" worlds of the sixties. Developing the concept that "small is beautiful," he focused on community level needs. He proposed small scale, affordable technologies that would have an immediate impact on improving the health and well being of under-developed communities. Rybczynski (1991) and others have debated appropriate technologies' contributions to sustainable development. While appropriate technology is not a panacea, it has demonstrated its potential to improve the quality of life when developed with community members as key players throughout the process.

In this community development context, it is important to frame a set of questions that help evaluate the effects of a proposed technology. These questions should set a standard

comparable to the environmental impact assessments that are now *de rigueur* for the implementation of any project. The questions must not be restricted to any particular set of issues. This open-ended approach will ensure that all issues that may be important in any given application context will be considered. Table 1 lists a sample set of questions.

TABLE 1
Checklist for Appropriate Technology Evaluation and Impact Assessment

1. **Does the project require small or large amounts of capital?**
2. **Does the project emphasize the use of locally available materials?**
3. **Is the project going to be relatively labor intensive or is it going to be capital intensive?**
4. **What is the scale and affordability of the project/technology? Can individual families in the community afford it?**
5. **Does the context of the project require a scale that is local or global?**
6. **Is the project/technology understandable without high levels of training? Can it be controlled and maintained by local community members without specialized education?**
7. **Can the technology be produced in villages and/or small shops?**
8. **Will the project contribute to community members working together to improve the quality of life/standard of living?**
9. **Does the technology/project process include local communities in technology/project innovation, modification and implementation?**
10. **Is the technology adaptable and flexible? Can it be adapted to different places and changing circumstances?**
11. **Will the technology/project have an adverse impact on the environment?**
12. **Is the technology/project sustainable, both with respect to the environment and to technology repair and replacement when and if skilled professional support is no longer available?**
13. **Does the project/technology offer the opportunity and have the potential to enhance local, national, and global justice and equality?**

The rationale for appropriate technology assessment springs from several perspectives. First and foremost, appropriate technology permits local needs to be met more effectively as community members become involved in identifying and addressing local community needs.

Appropriate technology also implies that tools are developed to extend human labor and skills within the community, not to replace or eliminate them.

Furthermore, appropriate technology, relying on local materials and skills, represents a scale of activity that is comprehensible and controllable at the community level. Appropriate technology permits a more economical technology development and implementation process by eliminating long-distance transportation costs. In the same vein, it makes expensive, and sometimes unavailable, financial, transportation, education, advertising, management, and energy services unnecessary.

With its emphasis on empowering local communities, appropriate technology helps establish a self-sustaining and expanding reservoir of skills within the community it seeks to serve, thus lessening economic, social and political dependency.

Appropriate technology is always situation-specific, depending on local community desires, geography, culture, location, availability of materials and other factors. Economic considerations are also critical. Judging appropriateness must reflect overall costs and benefits, including beneficiaries and payees.

However, non-economic criteria must play a large role in choosing appropriate technologies. The empowerment specified in the INAT protocol demands that technological choice be localized. And caution must be exercised with respect to institutional prejudices influencing technology choices.

*Portions of paper adapted from Verharen 2008, 2006.

REFERENCES

Chomsky, N. 2000. *On nature and language.* New York: Cambridge University Press.

Gawande, A. 2009. *The checklist manifesto: How to get things right.* New York: Metropolitan.

Hauser M. 2006. *Moral minds: How nature designed our universal sense of right and wrong.* New York: Harper Collins.

McDonough, W., and M. Braungart. 2002. *Cradle to cradle: Remaking the way we make things* New York: North Point Press.

Provonost, P. and Vohr, E. 2010. Safe patients, smart hospitals: How one doctor's checklist can help us change healthcare from the inside out. New York: Hudson Street Press.

Rybczynski, W. 1980. *Paper heroes: A review of appropriate technology.* New York: Anchor/Doubleday.

Schumaker, E.F. 1989. *Small is Beautiful.* New York: Harper Perennial

Tharakan, J., M. Castro, J. Trimble, D. Schwartzman, B. Stephenson, T. Broome, and C. Verharen. 2005. Diversifying Engineering Education: A Seminar Course on the Ethics and the Philosophy of Appropriate Technology, *Global Journal of Engineering Education* 9:2, 2005, 111-119.

Turner, T. 2001. *Controlling pilot error: Checklists and compliance.* New York: McGraw-Hill Professional.

Verharen, C. 2008. Survival Ethics: Consequences for Appropriate Technology. *Proceedings of the 3rd International Conference on Appropriate Technology.* Kigali, Rwanda: Ministry of Science and Technology, 2008, 268-274.

Verharen, C. 2006/08. Sage Philosophy, Rationality and Science: The Case of Ethiopia. *Ethiopian Journal of the Social Sciences and Humanities 4:2*, July 2006 (published March, 2008), 13-32