Transcending the Theory-Practice Problem of Technology

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Abstract: Design activities are fundamental to technological progress. Current design research holds tight to positivism, abandoned and critically opposed to by philosophers, mostly those outside the U.S. Maintaining the positivist view when conducting research leads to significant deficiencies in the quality of research, and to problems in transferring research results to practice. In spite of significant research efforts, the improvement of practice is slow. This improvement, in turn, does not necessarily reflects the diffusion of research results into practice, but rather, the development of ideas by practitioners. This paper analyzes this theory-practice problem of technology from practical, cultural, and philosophical perspectives. It proposes a research methodology of design and briefly shows how this methodology can shed light on some problems related to technology. The paper also discusses the fundamental role of design in technology, thereby viewing the research methodology proposed as a methodology for studying some aspects of technology.

Preface

Dear reader,

In this report, I aim at starting a dialogue about the reasons, nature, status, and potential solutions to the theory-practice problem of technology and design. Such a dialogue can start by asking readers like you to participate by sending me comments on this preliminary report. I will appreciate any comment, ranging from dismissing the ground on which I formulated the problem, through major criticism, to support of the methodology I propose. I am fully aware that the views expressed are represent a minority voice, therefore this report may elicit this full range of responses. I will appreciate comments reflecting different cultural and backgrounds and philosophical inclinations.

Sincerely

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Existence will remain meaningless for you if you yourself do not penetrate into it with active love and if you do not in this way discover its meaning for yourself. (Buber (1967), p. 212)

1 Introduction

The decline of technological competitiveness of many U.S. companies leads prominent researchers and practitioners to acknowledge that the relationships between design research and practice in the U.S. is in trouble (National Research Council, 1991). This American National Research Council's study is one amongst occasional reflections of design researchers upon their activities. While these reflections may include discussions about research methods for finding design knowledge, methods for studying designers in their work, or the lack of transfer of research results to industry, they lack several essential ingredients of an inquiry. They lack a precise view of the world (i.e., ontology), a view of the relationship between the inquirer and the world (i.e., epistemology), and a set of methods for finding knowledge about the world with their corresponding ways of interpretations (i.e., methodology) (Guba, 1990). And moreover, these three ingredients are intertwined with cultural background and political interests which are often neglected.

For example, if design researchers adopted the positivist view (as most do), they would have, as Guba (1990) contended, subscribed to a realist ontology, objectivist epistemology, and controlled experiments as methodology. In this study, positivism is interpreted broadly. It includes postpositivism, logical empiricism, analytical philosophy, and others advocating for any kind of universal method that is expected to derive and incrementally accumulate objective knowledge.

In spite of the decline of positivism in philosophy, mostly outside the U.S., it is still influential on researchers in many fields of inquiry. In addition, positivism provides a good characterization of how the public *perceives* the way research advances. Such a perception, and moreover, the predominant positivist belief that technology is simply applied science has severe consequences for the quality of practice. These consequences are instances of the practical *theory-practice problem*, henceforth denoted by TPP. A simple, idealistic characterization of the problem is that most researchers view themselves as capable of objectively creating knowledge about the real world, through the use of various scientific methods. Furthermore, researchers expect practitioners to use that knowledge. In contrast, practitioners, dismiss the viewpoint of researchers and further argue that researchers' findings are irrelevant to reality. Consequently, practitioners do not use research results. The final outcome is the lack of dialogue between researchers and practitioners on the problems faced by both. In this characterization, theory can be interpret as scientific laws, but also as tools or instruments developed in research, while practice is the the making of products associated with a specific profession or technology. The motivation of this study is to analyze some of the foundations of the TPP and to arrive at a design research methodology that can better facilitate practice.

At first glance, the goal just stated seems strictly pragmatic, yet, the goal of this study extends this notion. By improved practice I mean a shift from the positivist notion of "the domination of man over nature and over fellow human beings" to the quest "for preservation and nurture" (Floyd et al (1992), p. 19)

In this study, I attempt to analyze the cultural and philosophical foundations of the TPP and propose a methodological shift for design research informed by this analysis. The purpose of the shift is to restore the *true* dialogue between theoreticians and practitioners through a methodology of *participation*. The establishment of true dialogue may change the way research and practice are executed and also what problems that are to be attended to.

Usually, design is viewed as being subordinated to technology, since the latter involves a much larger social and cultural context than is addressed by the majority of design researchers. In contrast, I view design as a fundamental human activity underlying technology; therefore, a research methodology of design can be considered as a research methodology of technology. I will demonstrate this by answering key questions regarding the study of technology.

This study is divided into three major parts. The first part, consisting of two sections, discusses the *practical* aspect of the TPP. Section 2 reviews instances of the TPP covering the relationships between philosophers, researchers, and practitioners. The pragmatic problems of "getting things done," that many professional face, have attracted the attention of researchers in these disciplines. Invariably, as Section 3 demonstrates, most of the attention has been focussed on studying the TPP from the usual positivist viewpoint. Although some researchers begin to address the TPP from its philosophical viewpoint, not much attention has been devoted to the cultural perspective of the TPP. The first part ends with a sense that a stagnation point in solving the TPP has been reached.

The second part of the study, consisting of three sections, deals with the *theoretical* aspect of the TPP. Section 4 provides several explanations for the recent development of the distinction between theory and practice and its practical consequences. It situates the explanations in a cultural and philosophical foundations, elaborated in sections 5 and 6, respectively. Attending to these foundations is necessary for advancing towards solutions to the TPP.

The third part, consisting of three sections, discusses the new research methodology and its implications. Section 7 discusses the foundation of the new research methodology: *the* *design hypothesis*, arguing that *humans continuously engage in designing their experiences in the world.* This can be interpreted in several ways including: as an epistemological statement, namely, design of experiences is an instrument for understanding; or as an ontological statement, namely, designing experiences is a way of behaving.[1]

Both interpretations are not entirely new, they were advanced before by phenomenology, pragmatism, and other *praxis philosophies* (Ihde, 1979). I will illustrate these and two more important interpretations as they apply for all human participants in the process of technological change, concentrating on design as the fundamental activity underlying technology. Section 8 puts the design hypothesis into the practice of advancing design research by devising a new research methodology and demonstrating it in the context of a specific research project. Section 9 expands the design hypothesis into the practice of studying technology by discussing how the hypothesis applies to several questions underlying the study of technology.

Note that this study is not a philosophical paper; such paper, in my view, will be merely about *theory.* The literature contains considerable philosophical treatment of the TPP, but not that has led to the solution of the practical TPP. In addition, philosophy is not my domain of expertise, I merely rely on an impressionistic understanding of philosophy. This study is certainly not a technical paper in the common engineering sense; such paper will be strictly about *practice.* This study is about a combination of both, a property central to the theme of the paper: the collaboration between, and interdependence of theory and practice.

Part I: Practice

2 Examples of the theory-practice problem

Most researchers in all fields of inquiry, too immersed in the old natural science metaphor of technology, pursue their work independent of practice; nevertheless, they believe that knowledge they generate *ought* to be used by practitioners. They accuse practitioners of not complying with this belief, while being accused by practitioners for not supplying the information practitioners need (de Neufville, 1986). Such conflicts arise in diverse disciplines such as engineering design, public policy, education, and management. In fact, they *occur in all* disciplines involving humans activities.

A recent document of the American National Research Council (1991) described the poor relationship between engineering education, research and industry in the U.S.

[1] I choose not to use the term *being* since it may have a passive, indifferent connotation. *Behaving*, on the other hand, involves action, therefore, does not conceal that it has consequences.

> With few exceptions, engineering design education and research is divorced from industry needs. For its part, industry does not articulate its requirements, support changes in the design component of curricula, or view education as an incubator of design talent. University design research efforts are often isolated from industry, and industry rarely uses the results of university research. (p. 12)

Similar concerns have already been raised in a previous document of the American National Academy of Sciences, *albeit 24 years ago and with no apparent improvement* (National Academy of Science, 1967). While sections 4 and 5 attempt to explain the lack of attention towards such documents, this section elaborates on the views of the different contributors to the TPP.

Fishlock (1975) provided a vivid view of the scientist, reflecting a common metaphor of the researcher sitting in the ivory tower, pursuing work independent of reality.

> Scientists generally, anarchists as most of them are at heart, have not showed themselves overly sympathetic to their patrons' problems. They were pleased to find themselves after the Second World War in favor with a public persuaded that, if simply left to their own devices, they would produce answers in their own time to society's more intractable problems. But they resented any attempt by the patron to channel their cogitation towards one of those problems. They saw themselves participating in what essentially was a cultural pursuit. Their attitude seemed to be, if the patron had a problem to solve, then he should recruit lesser mortals for the task. (p. 69)

Some researchers believe that the pragmatism of practitioners or the "practical problems of daily life" may distract them from attending to the fundamental principles of nature or society which they *aught* to uncover. Therefore, they reject establishing committed relationships with practitioners. Moreover, they complain that their funding agencies ask them to do so. Warfield (1990) illustrated this viewpoint, when discussing problems in obtaining funds for basic research in systems engineering which, according to Warfield, stem from the contradictory viewpoints of researchers and practitioners. Warfield contended that

> the modern-day engineering and management community has worked itself unknowingly into a positivistic corner from which it lacks the imagination to escape. The leadership in American <u>scientific</u> funding agencies has largely passed to <u>engineers and lawyers</u>, whose knowledge of science is often slight, and whose dominant concerns lie with applications and adherence to poorly-drawn regulations. (p. 215, emphasis in the original)

Not only do researchers face problems from funding agencies and practitioners, they also have problems from philosophers. That is, the TPP also manifests itself in the relationships between different professionals and philosophers. From the viewpoint of suppliers of information such as research methodologies, most philosophers dealing with technology do not develop their arguments to the extent that they can influence research or practice.[2]

> The philosopher is a man wholly without influence, and he gained this unenviable position for himself by turning aside from philosophy to concentrate on the technical study of language; not its reference, mind you, which would take him outside language to the world, but only its meanings, which enables him to stay inside language, a kind of new scholasticism which leaves the real world to the care of others. (Feibleman (1982), p. 14)

From the other side, the public or professionals do not pay attention to philosophy.

> The typically enlightened individual has already decided that because philosophers use ordinary words in extraordinary ways, he could make no sense of what they said and wrote; at the same time he felt that he need not bother because he was not missing anything important. (Feibleman (1982), p. 13)

The negative attitude towards philosophy persists with researchers (Habermas, 1971). Except for rare exceptions,[3] researchers do not consult philosophy in determining their research methodologies or goals. Gasparski (1990), citing a document called the Boston Manifesto written by Nadler about planning and design (P+D) activities, warned against the "lack of awareness of the epistemological foundation of P+D." (p. 191)

Finally, there is even a discrepancy between philosophers' positions and how they practice philosophy. To illustrate, Feibleman (1976) said that "Hume working with the experiences of the senses alone (and neglecting the importance of the fact that he was thinking about them in so doing)" (p. 169) did not preach that thinking is important although he was using it to derive and articulate his ideas.[4] Such discrepancies between statements and actions are practiced by other professionals as well.

[2] There are notable exceptions to this statement, namely Marx and Heidegger. See note 4 about the latter.

[3] See Mallery, Hurwitz, and Duffy's (1986) discussion on the influence of philosophy on research on natural language understanding, Winograd and Flores' (1986) and Floyd, Züllinghoven, Budde, and Keil-Slawik's (1992) discussions on the philosophical foundations of the design of computer systems, and Arbib and Hesse's (1986) discussion on the relationships between philosophy and schema theory.

[4] The reader may view places in the text where he or she feels that a reference to Heidegger's (1927) *Being and Time* may be appropriate. Such reference will not be made. Heidegger demonstrated the extreme separation between ideas and practice: While philosophizing about the nature of *Being*, he became a member of the Nazi

The symptom manifested in the examples presented in this section is the lack of dialogue or communication between the theory and practice aspects of a profession or between professions. The dialogue and its role in enabling consensual understanding are central to the research methodology proposed later.

While I briefly cited cases where theory and practice are divorced from each other, I have not dealt with crucial issues that these cases raise. For example, while discussing the American National Research Council Document (1991), I did not discuss whether industry needs should be the driver of education or research or whether building a bridge between industry and universities will solve the TPP. In another example, while citing Fishlock, I did not discussed whether the patrons of scientists should or should not determine the research questions. The cases mentioned served merely to demonstrate the lack of dialogue between theory and practice.

3 Dealing with the theory-practice problem in practice

Several professions have noticed the problem of applying research results to practice. Fewer professions, such as education or political science, have tried to understand the problem from the philosophical perspective, and others, such as engineering design, have tried to look at remedying this practical problem by pursuing additional research from the same perspective.

Education

Some education researchers dealing with evaluating educational programs and their improvements have recognized the flaws in the positivist paradigm[5] of inquiry, and proposed to replace it by contemporary paradigms such as postpositivism, critical theory, and constructivism (Guba, 1990). Some researchers may view these paradigms as competing, but Guba, having a pluralist view, proposed a dialogue between the paradigms without the intention to identify one as the best, but with the hope that better paradigms will emerge.

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party from 1933 to 1945. His silence about the Nazi's atrocities during, but more importantly after, World War II demonstrated his *contribution* to the denial of the Being of millions of people. I leave it to Heidegger's followers to try and reconcile his theory and practice. See also, Farías' (1989) *Heidegger and Nazism*, and Neske and Kettering's (1990) *Martin Heidegger and National Socialism: Questions and Answers*, for a significant elaboration on this subject.

[5]The term *paradigm* used by Guba (1990) is related to, but different than, Kuhn's (1962) term. Kuhn's term was fuzzy, (if we judge by the many different ways it is used in his book,) and reflected a post-hoc analysis of historical events, whereas Guba's term is more precise and can be consciously selected to provide guidance in research. Guba's paradigm is an entity that materializes in the way it addresses three basic issues: ontology, epistemology, and methodology. Guba's term seems closer to Lakatos' (1987) notion of *research programme* than to Kuhn's paradigm. See also Kourany's (1987), p. 112-121, for a summary of the different views about the progress of science including Kuhn's and Lakatos'.

The collection edited by Guba (1990) contains papers, often with opposing views, on the issues central to paradigms such as ethics, implementation, and training. Elsewhere, Guba and Lincoln (1988) asserted that the selection of a paradigm *entails* the selection of its methodology, where methodology is the procedure guiding inquiry. Methodology is different from method, it includes the research method and its interpretation.

The success of the pluralistic view depends upon the dialogue between the paradigms. If a dialogue is possible and fruitful, thus leading to better paradigms, the pluralistic view may prove practical. Otherwise, the pluralistic accommodation strategy will fragment any profession adopting it. Note that the ability to engage in a dialogue departs from the incommensurable nature of different paradigms according to Kuhn (1962). In addition, true dialogue and change work against vested interests of practitioners of different paradigms therefore most probably will be rejected, an issue further discussed in the study. The uncertainty in the possibility of a dialogue casts doubt about the practical results from pluralism. The methodology[6] I propose later, relying on Buber's concept of a dialogue (Arnett, 1986; Buber, 1972; Buber, 1958; Buber, 1964) and critical theory (Geuss, 1981; Held, 1980; McCarthy, 1978), attempts to facilitate this necessary dialogue.

Public policy

Public policy researchers and professionals have also recognized the divorced nature of policy implementation from its conception, another example of the TPP. The volume edited by Palumbo and Calista (1990) contains papers on the implementation process in public policy, focusing on studying the problems of implementation and their proposed solutions. Palumbo and Calista identified two types of studies: the *top-down* and the *bottom-up* approaches.

The *top-down* approach contends that any emphasis on implementation undermines the foundation of democratic politics. It is the *right* of the elected officials to exercise their power. In contrast, the *bottom-up* approach emphasizes implementation, thus, concentrating on incorporating the actions of bureaucrats and client behavior into policymaking. Some bottom-up studies are aimed at uncovering conditions under which implementation fails or succeeds. These conditions, however, are again being studied through the positivist lens by engaging by deriving objective knowledge through controlled experiments; thus, will be used for modifying policies, but still without involving clients in policymaking.

Linder and Peters (1990) criticized the over emphasis of the bottom-up approach of implementation as if it exclusively determines the success or failure of a policy. They proposed to

[6] I explicitly do not use the term paradigm because, similar to Kuhn, I view the term as being fuzzy. Furthermore, I do not think that paradigms can be consciously selected based on some criteria; this to me is a positivist notion. See also note 5 and other chapters in Guba (1990) opposing the "discrete" notion of the term paradigm.

view policymaking as a social design process involving different actors, processes, and actions. While expanding the view of policymaking, they remained within the positivist camp, aiming at designing better policies through objectively "understanding" why policies fail and not, for example, through the participation of clients.

Fox (1990) summarized that the problem of all approaches is that as long as policy analysis is positivist, the interaction between implementation and street clients will not be understood. But Fox did not fully recognize the importance of *constant* reflection on methodologies when arguing that: "while practicing social scientists need not generally concern themselves with the philosophical underpinnings of their craft, in periods of paradigmatic turmoil a re-examination may be called for." (p. 200) The problem with this statement is that at times of reexamination, *there is no one that can recall the foundations*; and even if there was one, he or she will find it impossible to convince the remaining practitioners of the significance of attending to these foundations.

Social science

Social scientists also suffer from embracing the positivist view, thinking that their task is to discover basic scientific facts that eventually will be used in practice (Whyte et al, 1991). The contributors to the volume edited by Whyte (1991) argued that a participation in research of an organization studied in a research projects, via a methodology called Participant Action Research (PAR), can improve *both* practice and theory. This claim went beyond merely the pragmatic transfer of theory into practice. The adoption of the new methodology was pragmatic: first, several experiences have showed that it works, and second, organizational behavior is too complex to limit researchers from accessing whatever inquiry method is available. PAR is close to the methodology proposed in this study. However, the present study goes beyond promoting a pragmatic view. It elaborates on the foundations of the new methodology and shows how difficult is, or may be, its adoption.

The adoption of PAR involves overcoming several difficulties. First, following the positivist tradition in natural sciences, most social scientists fear that PAR prevents the attainment of the desired scientific rigor. Second, the premise that PAR improves both theory and practice provides an incentive for researchers and owners/managers of organizations to engage in PAR. Unfortunately, almost always low-ranking organizational members are required to participate in PAR, and although advocates of the bureaucratic (and positivist) view of management would like us to believe that the workers interests correspond the owners' interests (Waring, 1991), these interests are usually conflicting. In fact, in the Xerox PAR project discussed by Whyte, Greenwood, and Lazes (1991) , the workers, facing layoffs, had no choice but to join the PAR project.

With respect to scientific rigor, Argyris and Schön (1991) criticized the reasons given by Whyte *et al.* for engaging in PAR and their written analysis of the Xerox PAR program. They argued that experiencing PAR is a *must* if relevance of research results is a true goal. They said that rigor can also be achieved if certain precautions are taken. In particular, an analysis of a PAR should: include views from all participants, alternative explanations to the action progress must be explored, and all details of the action must be articulated to constitute "good" science.[7]

With respect to the interest problem, von Hippel (1988), in his research on the sources of innovations, discussed how close relationships between manufacturers and customers allowed customers to innovate on the products, thereby benefiting from better products in conjunction with manufacturers' success. A closer look at the phenomenon showed that innovations made by customers were made when they were cost effective from the customer viewpoint, and innovations by manufacturers were made when they were beneficial from the manufacturers viewpoint. Therefore, it may not be accurate to attribute the innovation to close relationships, but to the satisfaction of selfish interests. In another study, von Hippel (1987) showed that practitioners from competing firms engaged in communication. He explained it by a model showing that in certain situations such communication may be beneficial to both companies. He did not consider, however, the plausible explanation that the communicating practitioners have different interests than those of their companies, and that they may engage in communication benefiting them but harming their companies. These examples further demonstrate the difficulty of understanding why and how fruitful interactions between manufacturers and customers, practitioners from competing companies, or researchers and low-ranking organizational members, can be facilitated.

Design

Urban design practice is slowly, but constantly, moving towards incorporating user concerns into the design process (Hulchanski, 1977; Huls, 1986; Susskind and Elliott, 1983). The relatively smooth and continuous spread of customers' participation in urban design in many countries points to the high acceptance of such practices; it is based on democratic principles that do not risk any of the participating parties.[8] Note that such participation may sometime require

[7] Note that although Argyris and Schön critic can improve PAR, their view is still within the positivist paradigm since control over research rests in the hands of researchers and is not distributed to other participants. Elsewhere, Argyris (1980) and Schön (1983) expanded these ideas in ways that can easily and mistakenly be perceived as similar to PAR. However, in other publications they provided a detailed analysis of the defensive routines used by individuals and organizations (Argyris, 1985), thus giving tools for manipulating these routines to obtain a desired change. See also Waring (1991), for a review of central ideas in management theory including similar categorization of Argyris' views.

[8] The concept of participation is not always acceptable from the perspective of architects—the agents mediating between the customer agency and the user community—who instead of attending to the customer, often develop

the development of new design concepts such as the support-infill concept for housing (Carp, 1986). The volume edited by Sanoff (1978) went further than discussing the participation process from the designer standpoint by providing potential participating communities with information about design knowledge and participation.

The situation in engineering design is more complex than the one in urban design. In what follows I mainly concentrate on its status in the U.S. Forced by the problems faced by design practice and their serious consequences on industrial competitiveness, the engineering design research community in the U.S. tried to understand the problems and propose solutions (National Research Council, 1991). As seen from problems in implementation research, a positivist rhetoric used in writing some of the conclusions of the above study, such as

> manufacturing firms *should* recognize the leverage afforded by engineering design and move to take advantage of it; implement a comprehensive, coherent product realization practices; create a supportive environment for design; establish dedicated functional change agents to implement new practices and organizations; ... continually and formally seek and incorporate the best practices as they evolve; and adopt modern management accounting systems;" (p. 68; my emphasis)

does not serve the purpose of the study. Demands from industry, without taking into account the social and cultural issues involved are unlikely to be taken seriously. Furthermore, as Hughes (1991, p. 22) argued in another publication of the American National Academy Press, such demands reflect a *reductionist and distracting view.*

To illustrate this distracting view, in the introduction to another document published by the National Academy Press (Sladovich, 1991), White, the president of the National Academy of Engineering, said that the views of Hollomon, the founder of the Academy, on the challenges of engineering are still valid thirty years after their exposition. A closer examination of Hollomon's views, reprinted in that document, suggests that the ignorance of his challenges reflects a deeper problem than one that can be solved by *making sure* that industry uses research results. Hollomon starts by saying "I turn my attention from science to engineering—from understanding to doing." (p. 104) This statement seemingly modified his focus from the quest for knowledge or truth to the meaning of technology in society and the interpretation of that meaning. Hollomon proposed potential solutions to the problem of practice, such as the establishment of research laboratories in industry, the support of research aimed at understanding the issues in knowledge transfer from science to industry, and the education of engineers with sociology in addition to science. Nevertheless, Hollomon maintained the elitistic view of science as the only mechanism

myths about authoritative rationality and aesthetics judgment (Ward, 1989).

for seeking the truth, and consequently, as history has showed, his ideas have not attracted attention.[9]

The National Research Council report, previously discussed, also recommended advancing design education and design research. Since these recommendations may be viewed as proposed policies, they are subjected to the same implementation issues discussed before. Note that some of the recommendations for design researchers, such that they should engage in industrial relationships and even become industrial interns for a certain period of time, can be easily enforced if, for example, federal funding becomes contingent upon fulfilling these requirements. A soft version of this idea is implemented in the Engineering Research Center program of the U.S. National Science Foundation (National Research Council, 1986b); the program demands that centers develop partnership with industry. This however, rarely guarantees that real problems are addressed in research or that research results become valuable in practice. Some researchers, such as Bucciareli (1988) or Hales (1987), did not wait to be forced to establish relations with industry and performed design studies in actual industrial setting, understanding that a better appreciation of design can be conceived through properly studying actual design practice.

Within another fragment of the design research community, problems observed in design practice in the U.S. have resurrected the old debate about the need for design science. Calls advocating for the push towards design science have been coming from system sciences (Warfield, 1990b), from social sciences, albeit with a strong positivist view (Simon, 1981), and from engineering (Dixon, 1987). Design science, will culminate as a host of theories that are derived by *the* scientific method, can explain and predict phenomena, and can control and manipulate situations (including humans within these situations).

Outside the U.S., several design theories, founded mainly on systems science or philosophy, were developed in the past (Gasparski, 1984; Hubka and Eder, 1988; Yoshikawa, 1981). While Gasparski (1981) argued for participation in design, similarly to the methodology I propose, Hubka and Eder, and Yoshikawa concentrated on the technical knowledge involved in design.

Unfortunately, according to Ullman's (1991) analysis, the situation of design research in the

[9]In is interesting to note Hollomon's reference to a statement by Solomonov from the Academy of Science of the former U.S.S.R:

> The power of contemporary science and technology is such that they can, in principle, provide the highest level of well-being for all people on the globe. But capitalist society is organically incapable, by virtue of private vested interests, of fixing this goal as an organized aim of society and state. (p. 110)

This criticism is more valid than Hollomon's own closing statement on the challenges engineers face in modern society: "I believe that engineers will not fail to accept this supreme challenge to our way of life. We—you and me—must meet it." (p. 110)

U.S. is in a bad state. Only very few researchers are engaged in searching for philosophical foundations for design research, while ignoring that such omission may lead to the formulation of flowed design theories.

It is an unfortunate fact that even those favoring advancing design theory or science rarely advance it. Dixon (1987) criticized this situation while discussing proposals for getting research grants: "Proposals rarely advance theories or hypotheses. When they do, it is rarely a testable theory or hypothesis. When it is testable, actual testing is rarely proposed. When a test is proposed, it is rarely well conceived." (p. 147)

In a recent study (Reich, 1991a; Reich, 1991b), I tried to address Dixon's concern by discussing methodological issues of design research. In these papers, I demonstrated the benefits from iterative theorizing and experimental testing to the quality of both a mathematical theory of design and an experimental design system. Therefore, these papers can be of value to those developing a theory of design, and especially to those advocating for a Popperian notion of scientific method. These papers, however, did not address the social aspects so crucial for design.

Konda, Monarch, Sargent, and Subrahmanian (1992) went further and explicitly criticized the call for design science as a collection of theories derived by any universal method. Konda *et al.* based their analysis on the philosophy of science, the largest single subject in philosophy, even though not the only relevant to design. Konda *et al.* nevertheless used it since it was most *appealing* to their audience; if they could base an argument on this branch of philosophy, instead of on the philosophy of sociology, they could make a stronger impact on their audience. Hence, by showing that scientific progress cannot be accounted for by any universal method, as demonstrated by the historical analysis of Feyerabend (1975) and Kuhn (1962), they correctly argued that one cannot conceive of a universal method for supporting the progress of design processes.

After rejecting the notion of general methods for determining design progress, Konda *et al.* promoted the idea of shared memory as a unifying theme for research and practice. Shared memory can promote sharing the meaning of requirements and design actions and keep historical data for future use.[10] This study will suggest that the next question to address is how to create facilities for communication that can promote learning and thus can lead to and support such sharing, or to put it differently, the next crucial question is: "how shared memory is possible?"

[10] There is seemingly a similar trend in design research to work on the capturing of such data as "design rationale," augment it with additional knowledge-bases and use it to generate better designs. The shared memory is different than this attempt at "objectifying" knowledge, in that shared memory always refers to specific contexts. Any generalization is subjected to revisions and is still attached to the context in which it was generated.

The relations between theory and practice discussed before do not lend themselves to a clear resolution. While I just proposed what I perceive to be a crucial research question for design research, it is by no means accepted by design theorists. Most design theorists will simply dismiss the TPP and continue to pursue their common research agenda. I, on the other hand, hope to have raised doubts about the easy resolution of the TPP and explained that the differing and sometimes contradicting or antagonistic viewpoints about the TPP do not help shed light on potential solutions. Reinharz (1990) also discussed the relations between research groups favoring the positivist and alternative paradigms (e.g., constructivism, critical theory) in sociology. She portrayed a grim situation of either implicit ignorance or explicit antagonism towards the "rival" paradigm. Presently, the "alternative" group is an oppressed minority. Since most sociology departments in American universities are positivists, they do not hire professors from, and do not train researchers in, the alternative paradigms thereby contributing to the present tendency. Through the lack of training, the positivists constantly deprived their younger generation from making a thoughtful choice about their research paradigm. The inferior status of the alternative paradigms is manifested even in the use of prejudiced metaphors such as gender to describe the paradigms (e.g., the male positivist and the female alternative).[11]

What is the essence of these contradictions? For Bernstein, it will be a consequence of the "Cartesian Anxiety." (1983, p. 16-20) This anxiety is the experience that a foundation for our knowledge, an Archimedean point, is nowhere to be found and the fear that this may lead to "relativism, skepticism, historicism and nihilism." (p. 2-3) I claim that this anxiety is the expression of an *oppressive* state of affairs we inherited. Similar observations have been made by others (Geuss, 1981; Habermas, 1971; Maxwell, 1984; Reason, 1988).

Not only are members of the alternative paradigms oppressed, but I argue that also the positivists cannot escape oppression or loss of meaningful activity.[12] To advance their career, American researchers submit themselves to the unfortunate *publish or perish* research paradigm. The publication of many papers requires engaging in many large fanciful projects that are often expensive. In addition, researchers "hire" groups of cheap graduate students to produce research results. Therefore, instead of doing research, presumably the reason the positivists chose their profession, researchers become administrators and fund-raisers working "around-the-clock" to maintain a high positive cash flow. Consequently, the cost of projects or the

[11]See Nowakowski's reaction to Reinharz's chapter where she noted that "to accommodate the metaphor, for example, of gender, one has to accept the stereotype of the metaphor (i.e., female equates with soft and weak, and male with hard and strong) as well as the stereotype of the paradigms." (p. 309) I argue with Reinharz that one need not accept the stereotypes, one can oppose them, but still acknowledge that they are more than often put to use by others.

[12]See Arnett (1986), p. 134, for an example.

success of the fund-raising activity become a major criteria for evaluating research or researchers. Moreover, members of the community find themselves spending substantial time in reviewing the submissions of papers and proposals of their peers. While this is a distorted situation, it is not the end of affairs; without noticing, "research participants becomes [sic] objects—targets, others to be acted upon—rather than agents who work to understand and change their own situations." (Lather (1990), p. 327)

Part II: Theory

4 Recent development of the theory-practice problem

This section starts the second part of the study. In the previous part, the practical status of the TPP was outlined, this part provides the "theoretical" status. The present gap between theory and practice has evolved over many years, but this section is interested in its recent development. This section traces the development to the emergence of the sciences and their separation from philosophy, to the attitude of educational programs influenced by the culture in which they are embedded, and to the ignorance of social aspects in research. All these aspects need to be reversed if a solution to the TPP is sought.

In relation to the U.S., Feibleman (1982) proposed a historical course of events leading to this situation. First, the positivists viewed scientific knowledge as the only valid knowledge, and viewed the task of philosophy as merely a commentary on science. This led positivism into a position where it could not contribute anything to the process of gaining knowledge and therefore the movement shrank.[13] Meanwhile, it left a mark by placing a so-called desired distinction between theory and practice. Second, the pragmatism in the U.S. reinforced the negative effects of positivism by stating that what works is true. These two contradicting views, placing high value on only one of the theory-practice poles, intensified the TPP. Ihde (1979) articulated a similar explanation. Until recently, philosophers were also the practicing scientists. This started changing during the Renaissance and accelerated in the 19th century. There were two ways for the philosophers to react to the newly emancipated sciences: accommodation and reclamation. The positivist accommodation way allowed the new sciences to co-exist such that each branch can pursue its goals "freely;" while the phenomenologist reclamation way tried to reformulate the foundations of the new sciences and bring them back into philosophy. Both methods were not successful; the first led to ignorance while the second to lack of cooperation.

Beside the contribution of philosophy, there were educational influences on the development

[13]Similarly, Toulmin (1972, vii) evaluated the philosophy subsequent to the Greeks to be a footnote to Plato.

of the TPP. In relation to engineering, over the years, learning the practice moved from an apprenticeship mode of acquiring skills to the education mode of acquiring engineering skills almost inclusively consisting of analysis and scientific theories (Kerr and Pipes, 1987). Le Moigne (1981) provided two explanations for this transition. First, when this transition took place in Europe at about 1750, when the first engineering schools were founded, engineering schools where not well established and borrowed the scientific metaphor to gain acceptance. Second, some training schools, such as the military schools, preferred training "executing" technicians, rather than "responsible" designers. Brown (1936) described a similar course of events in the U.S. From 1812, when the first school was opened, to 1870, the focus of education was on practice, thereafter, a marked change towards the sciences took place. The scientific metaphor of engineering education persists until today and moreover has been constantly strengthened since World War II (National Research Council, 1986a; Schön, 1983). In the above educational process, engineers tended to suppress their intuitive and feeling faculties by relying on reasoning (Mumford, 1952). Schön (1983) also explained

> I have become convinced that universities are not devoted to the production and distribution of fundamental knowledge in general. They are institutions committed, for the most part, to a *particular* epistemology, a view of knowledge that fosters selective inattention to practical competence and professional artistry. (p. vii)

The same basic attitude of universities continues at the Ph.D. level when training the researchers of the future. According to Eisner (1990), "professionally socialized doctoral students in schools of education are often unable to question the premises upon which accepted research method rest. We usually do not encourage them to consider alternative—or haven't until quite recently." (p. 89)

Since universities, and mostly engineering schools are those educating practitioners, each practitioner, being a theoretician, ignores the practical issues of his or her work. On the other hand, each practitioner, being a practitioner, cannot understand the issues discussed about his or her profession by the theoreticians. As a practical person, the practitioner remembers the disrespect from the theoreticians, which can be traced to the Greeks' view on the superiority of *theoria* upon *praxis*. Therefore, the practitioner does not want to get involved in the theory of his or her work. The practitioner will respond to potential interaction from the theoretician by saying "while I do not accept *your* view of knowledge, I cannot describe my own." (Schön (1983), p. viii; emphasis in the original)

Simon, at his 1969 lecture at MIT (Simon, 1981), outlined a program for teaching the new science of design. However, Simon's suggestions have not received serious considerations from engineering schools although they are hard-core positivistic. I would argue that even Simon's ideas were too radical for traditional engineering schools that still suffer from an inferiority complex towards science. In light of this argument, a call for a new liberal art of design (Buchanan, 1992), is likely to receive no more attention by engineering schools than did Simon's ideas.[14]

There are additional causes maintaining the gap between theory and practice. To illustrate, most previous research on engineering design has concentrated on the activity of a single designer, and mostly on the analysis techniques the designer uses or *should* use. This seemingly enabled, although incorrectly, ignoring social issues in the development of design support tools. Naturally, the analytic/linguistic paradigm of philosophy was adopted, resulting in the development of logic and languages for representing and solving design problems. The products of this research paradigm are useful for some engineering activities since they may provide capabilities that can complement or extend human abilities. Nevertheless, except for few exceptions, research results are not used by designers.

Research on engineering design hardly pays attention to the actual design practice in large organizations. In fact, beside few exceptions such as Hales' (1987) study, detailed observational studies are nonexistent in the literature: while it is currently understood that the major impediment for *technological progress*[15] is the support of design activities involving large group efforts, necessarily, bringing in social and psychological concerns. This new emphasis of research on group work, cooperation, communication, and sharing as methods for effectively and concurrently developing new technologies requires a shift in philosophical emphasis to the experiental/continental paradigms of philosophy.

Reversing the current trend in research and practice is hard, as discussed in section 3, researchers find it hard to give up or "free" themselves from their positivist positions. They tend to explore and research the *sources* of problems instead of *solving* them. Furthermore, as will be discussed in the next section, any solution must take into account the cultural context in which it is advanced. Failure to attend to the underlying culture and its philosophy renders the solution almost impossible.

[14] Simon's ideas about design science, rationality, hierarchical human organizations as an evolutionary response to complexity, etc. do not remain without criticism. For a recent explicit critic on Simon's ideas, see Waring (1991), while for a critic on the dogmatic use of "rational" models of decision theory in social science and administration management, see Habermas (in McCarthy, 1978).

[15] Technological progress in this context means the ability to develop better, larger artifacts, but certainly not answering crucial questions such as the ethical problems technology raises.

5 A cultural perspective of the theory-practice problem

The development of the TPP discussed before was contextualized in the Western, or specifically in the American, culture. It is clear that different cultures give rise to different circumstances that may lead to different relationships between theory and practice. One example is manifest in the different ancient conceptions of theory and practice shared by the Greeks and the Babylonians' or Egyptians (Spielberg and Anderson, 1985). The Greeks thought that human understanding is dependent on God's illumination, and of course, their philosophers, the knowledgable people, insisted that knowledge comes through a divine mind. The Greeks valued scientific knowledge (*theoria*) more than other two types of knowledge: the practical (*praxis*) and the technical (*poiesis*). Knowledge of science was knowledge of the "Good." Studies on arithmetic, geometry, and astronomy were carried out for the purpose of understanding their essential notions as related to the "Good." In contrast, the Babylonians and Egyptians were more concerned with the practical aspects of their scientific investigations; they used the accurate astronomical data they have accumulated for the purpose of commerce, surveying, civil engineering, and navigation. In order to examine the contemporary cultural perspective of the TPP, I will briefly examine Japanese culture and economical success as a reflection of a fruitful relationship between theory and practice (Fujisawa, 1959; Moore, 1967; Morishima, 1982).

Often, when we read an analysis of Japanese technological organizations distilled from cultural background such as Odaka, Ono, and Adachi's (1988) or Shingo's (1989) studies of Japanese automobile industry, we tend to think that Japanese success depends on methods that can be borrowed and implemented independent of their larger cultural context. Brown and Daneke (1990) maintained that, "studies continue to fall prey to a sort of 'forest and trees' problem. ... Several studies have failed to grasp the complex web of synergistic interactions between strategic management, technological innovation, and the broader sociocultural system in Japan." (p. 144) In an attempt to remedy this flaw, Brown and Daneke briefly discussed special features of Japanese organizations, stemming from Japanese culture, which is so different from U.S. culture. Japanese firms stress long-term organizational survival and growth, leading to the development of long-term relationships between the players in the organization success such as: employers, subcontractors, distributors, banks, etc. These players are considered as priceless resources for the organization. The close relationships between the participants, leading to mutual dependency, enable the development (and evolution) of common goals that guide the organization. Shared goals allow for sharing risks and better communication, resulting in more innovative and good quality products. Therefore, the successful technological outcomes are facilitated by processes embedded in the Japanese culture; these processes, however, are not detailed in this study.

Even if the success of organizations is heavily dependent on culture and cannot be replicated elsewhere, maybe it is still feasible to borrow specific tools or methods. Hauser and Clausing (1988) discussed the "house of quality," the basic tool of the management approach known as quality function deployment (QFD) originated in Japan. The central motivation behind QFD is the belief that products should reflect the customers' will. The implementation of this belief requires devising procedures/tools for communicating customers' will into the design and manufacturing processes. This communication is not enough,[16] what is needed is that "companies learn from customer experience and reconcile what they want with what engineers can reasonably build." (p. 64) To achieve this reconciliation, the "house of quality" is also used to record the views of the engineers, and other participants in the process.

There is no fixed procedure for using the information detailed in the house, the house's main purpose is to promote *understanding* the priorities and goals of all groups involved in the design process. The useful use of the information requires having the "right" cultural inclination to engage in the communication, negotiation, and sharing activities. As summarized by Hauser and Clausing,

> what is ... not simple is developing an organization capable of absorbing elegant ideas. The principal benefit of the houses of quality is quality in-house. It gets people thinking in the right directions and thinking together. For most U.S. companies, this alone amounts to a quiet revolution. (p. 73)

Similar to Brown and Daneke's study, Hauser and Clausing's study, although acknowledging the significant role of culture, did not address the cultural and philosophical thoughts underlying the successful use of the "house of quality." In what follows, I attempt to better tie Japan's economical success to its culture and philosophy.

Contemporary Japanese culture and philosophical thought owe their origins to the introduction of Taoism, Confucianism and Buddhism from China and their blending into the native Shintō whose universal relativism facilitated the integration of the new philosophies.[17] Instead of simply borrowing these philosophies, the integration involved adaptations that suited the interests of the ruling family (Miyamoto, 1967). On the one hand, the new harmony fostered strong community ties, loyalty, and nationalism; while on the other hand, it prevented individualism and liberalism from influencing the Japanese society.

[16] Some may argue that customer will is enough and, furthermore, that tough customers can lead to good designs (Gardiner and Rothwell, 1985). They, must however, also acknowledge that doing business with tough customers may involve substantial risks and possibly failures.

[17] Fujisawa (1959) described the new combination as a harmony where "Shintō is the root and stem and Confucianism the leaves and branches, while Buddhism is the flowers and fruits." (p. 2)

The nationalistic attitude of Japanese, which puts the interests of the community above those of the individual, and the Shintō's relativism, which could transcend common Western dualisms, had a profound influence on Japanese history. In his forward to Carter's (1980) book, Kasulis discussed the conscious decision of Japan to modernize itself as a means of self-protection against any imperialistic endeavor so common in the middle of the 19th century. Whereas the early Meiji intellectuals thought that the modernization is independent to maintaining the Japanese culture, latter intellectuals became skeptic. The understanding that culture and technological progress cannot be separated went as far as suggesting that the Japanese people convert to Christianity, which as an individual faith could be practiced, according to Fujisawa (1959), parallel to the Shintō communal faith. Although, few Japanese converted to Christianity, the idea itself shows the extent to which Japanese appreciated the influence of culture and religion on technological change.

The Japanese experience tells us that there is an iterative or intertwined relationship between culture and philosophy and economical success or politics (Morishima, 1982). If it is an explicit aim that certain material conditions be changed, for example, the relationship between theory and practice, for the purpose of advancing technology, it is crucial to appreciate the potential difficulties in trying to borrow techniques from different cultures. As Morishima said:

> it is not only that a given ideology frequently plays a role of crucial importance at a turning point in history, but also that it has the effect of restricting the possibilities of day-to-day economic activity to within the framework peculiar to that ideology. ... No country can progress while it disregards its own past which constraints its subsequent course of development. ... A policy which has been proven to be successful for Japan may turn out to be unworkable in Britain and vice versa, because of the differences in their ethoses, in the ways of behaviours of their peoples and in all the other cultural characteristics which they have inherited from their respective pasts. (p. 200-201)

Since the successful borrowing of techniques from one culture to another involves certain adaptations of the target culture, a new problem, which I call the *impersonation problem*, arise within the positivist perspective. Namely,

> *given a group of people from a target culture having some desired goals; select a source culture among all cultures that provide directions for achieving these goals,*[18]

[18] I do not deal here with how the understanding of these cultures and techniques is obtained. One can argue that this understanding already involves the ability to impersonate members of these cultures because this problem is just an instance of the classic problem of achieving objectivity in hermeneutics. In addition, the impersonation

such that each member of the group can impersonate a person of that culture to the extent that he or she can follow the directions successfully.

The deficiency of the above formulation is that it assumes that people can engage in a rational selection between cultures, a view in line with positivism. This granted, I can illustrate the difficulty of solving the problem as posed. The ability to engage in the impersonation process is a function of the preparedness of each individual in the ethos of the new culture. To illustrate, if the goal is the attainment of economical success or technological progress, there are several target cultures, all different in some aspects, that can provide some directions, the Japanese or Scandinavian being two examples.[19] Therefore, it is important to study their cultures and make their philosophical foundations explicit to facilitate an informative decision as to the selection of the source culture.

If the target culture is the American, there may be several problems in borrowing techniques from either the Japanese or Scandinavian cultures. To briefly illustrate, both cultures have a strong notion of community interests: in Japan they are above those of the individual and in Scandinavia they facilitate the good of each individual (Floyd et al, 1989; Scott, 1975). In addition, Japan's ignorance of individualism and liberalism and the Scandinavian socialism (or egalitarianism) are embedded in techniques used to further technology and economy. If techniques are to be borrowed from these cultures, the American impersonator will have to select between nationalistic or socialistic principles, not an easy choice indeed.

Although the borrowing of methods is difficult, there are special cases where techniques could be borrowed successfully, in particular, when common interests where established or recognized before the techniques were used. Two examples discussed before are the Xerox PAR project in which workers *had* no choice but to participate and von Hippel's examples discussing acts of communication/participation between two beneficial parties.

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process involves a therapeutic process whereby the person undertaking these goals understands his or her present wrong behavior and is willing to engage in its modification.

[19]In Scandinavia, hard living conditions over centuries, sparse population, and relatively freedom from occupation have led to a strong sense of dependability and an appreciation of the need of each individual to attain the highest quality of living (Floyd et al, 1989; Scott, 1975). This humanistic driven pragmatism has evolved through favorable historical course of events into a culture committed to attaining good quality of life through: long-range planning, attention to individual needs and interests, cooperation between different social groups, pragmatic use of technological innovations, etc. These cultural foundations have led to distinct methods of *participation* in many aspects of technological change (Floyd et al, 1989; Namioka and Schuler, 1990). For another short but concise analysis of the differences between the German and the English/American traditions see Pusey (1987, p. 15-17).

6 The theory-practice problem in philosophy

So far, I have concentrated on the practical, cultural, and developmental aspects of the TPP. This section deals with the philosophical background of the problem. Two perspectives are discussed: the mind-body problem, which is the simpler in the context of this study, and the more involved *theoria-praxis* distinction.

The mind-body problem

The TPP is one of the dualities that can be associated with the mind-body distinction since theory originates in the mind and practice is the action of the body. The mind-body distinction has been prevalent in many cultures, since ancient times (McDougall, 1961); and has another analogue beside the TPP, namely, the relation between science and technology (Ihde, 1979).

There are at least four alternatives for viewing the mind-body problem (Ihde, 1979; Levinson, 1988). (1) Identity: Mind and body are two manifestation of the same thing. Contemporary views about identity often turn to be one of the following two reductionist views. (2) Materialistic: This view reduces mind to nothing but a brain matter. This view is advocated by Artificial Intelligence which inspires a significant part of design research; on the other hand, the AI view of science and technology is idealistic: Science precedes and is more important than technology. (3) Idealistic: This view reduces everything we perceive to be the creation of the mind; it is unpopular in contemporary epistemology. (4) Dualistic: This view regards mind and body as separate entities that interact. This dualism maintain that the interaction will always sustains its epistemological significance even if one would devise an explanation of ideas as derived from matter (or vice versa). The distinction will prevail since any explanation is bound to be fallible (Popper, 1965).

The mind-body dualism does not imply irreducibility. In fact, technology is a manifestation of ideas in material or material embodiment of ideas. It therefore refutes the strictly materialistic or idealistic views. Moreover, it represents a continuous interaction between the mind and the body.

Levinson (1988) discussed the attempts of several philosophers to address the mind-body problem. Kant thought that "human knowledge is the alteration of our experience or knowledge of the world that inevitably occurs when we experience or know the world." (p. 69) By this, Kant provided an answer to the epistemological problem about the source of knowledge and provided insight about ontology: without mind, the world is a senseless place. The objection to Kant is that his analysis discussed the interaction of mind-matter from the perspective of the human intellect only and neglected the changing nature of the world. Both flaws can be fixed by introducing technology as the interaction between mind-matter and as a continuous re-rendering of the world. This change is the only distinction between technology as an embodied interaction and an unembodied knowledge.

Acknowledging the changing nature of the world requires emphasizing the actions that change it. Marx emphasis on action while downplaying the contribution of the thinker looses some of the importance of technology as an interaction of mind-matter; nevertheless, Levinson says that "In making the act of labor a labor of love, Marx restores much of the quintessentially human aspects of technology which his downplaying of mind loses." (p. 75) Marx interactionism is partial because it is fully materialistic, a contrast to the fully intellectual interaction of Kant.

Popper's "three world" scheme is the most illuminating for understanding the interactionist mind-body system (Levinson, 1988): World 1 is the material world, World 2 consists of the subjective realm of thinking, feeling, and imagining etc., and World 3 consists of the results of processes such as ideas, strategies. Levinson modified this structure to be: W1 which consists of all natural and living material but humans, W2 which consists of humans, and W3 which consists of human ideas that were *communicated* (not-communicated ideas remain in W2). Communication gives ideas, not just their embodiment in material, but more importantly, a life of their own.

If a view is to be consistent, the same relationship should prevail in the three analogues: mind-body, theory-practice, and science-technology. While the interactionist view easily applies to all, the materialist mind-body view of most positivist scientists (Ihde, 1979) contradicts the idealistic view of science that they practice. In fact, for some researchers, the idealistic view of science allows ignoring the impact of the "value-free knowledge" they generate, while their research is sponsored by agencies for the materialistic purpose of developing unethical technologies.

I adopt the dualistic view and maintain it through the three analogues. By making sure that consistency is maintained, I prevent the distortion introduce by the inconsistencies of the materialistic mind-body view.

The theoria-praxis distinction

The second perspective of the TPP originates from the distinction between Aristotle's concepts of *theoria* and *praxis*. *Theoria* was concerned with theoretical knowledge (*episteme*́) of the given things in the world or with knowledge "for its own sake." *Praxis* was concerned with knowledge about the politics and ethics of practical discourse or judgment (*phronesis*). In addition to these two concepts, there was *poiesis*, dealing with productive knowledge or technical skills (*techné*). Aristotle viewed both *phronesis* and *techné* as preconditions of the life of human organizations, but such that could not be derived or justified by theory (McCarthy, 1978). Both three metaphysical categories of knowledge contained a theory and practical aspects and were in fact ways of living (in addition to the fourth way of those hard laborers at the bottom of the social structure) (Hickman, 1990).

While the industrial revolution was the result of *techné*, the view of technology as applied science was since strengthened, even though engineers occasionally criticized this view (Vincenti, 1984). This trend pushed the *theoria* sphere into the *praxis* sphere and made the *praxis* sphere to be simple *techné* (McCarthy, 1978). It is the aim of this study to try and recover *praxis* from its current position; furthermore the growing complexity of artifacts built today and their dependence on social processes make *praxis* more crucial to design than *techné*. Therefore I will concentrate on the relations between *theoria* and *praxis* henceforth.

The TPP starts with the hierarchical structure of ways of living the Greeks devised. Putting *theoria* on top as superior to *praxis*, makes it appealing for people to argue that they practice *theoria* rather than *praxis*. In the seventeenth century, Hobbes argued that science is a legitimate way to study human behavior. Thus, given the right knowledge (which few could have), it would be possible to manipulate human life toward proper ordering. Beside being ideologically incorrect, this view wrongly assumed that values can be subject to scientific inquiry. In contrast, science could help

> " in analyzing the preconditions and consequences of a given course of actions, ... or even in criticizing proposed ends from the point of view of their technical feasibility. But the choice of ends itself, the adoption of certain interests to the exclusion of others, was ultimately a question of values and not facts, a matter for decision and not for demonstration. The failure to recognize and honor this strict separation of knowledge from morality was a principle cause for the retarded development of social *science*. The traditional insinuation of normative considerations into social inquiry could result dogmatism and ideology but never in the cumulative progress of objective knowledge characteristic of empirical science. (McCarthy (1978), p. 5, emphasis in the original)

If we break away from the positivist view of science as Feyerabend (1975), Habermas (1971), Kuhn (1962), Maxwell (1984), Toulmin (1972), and others have been telling us we will be able to appreciate contemporary science as a practice of politics but lacking ethics. It is the result of the ingenious design of positivism: first, positivism turned the question of the practice of science (i.e., its politics and ethics) to the practice of the scientific method only, and then, positivism excluded discussion about the conduct of science as being outside the scope of inquiry by being non empirical or unscientific (Maxwell, 1984; McCarthy, 1978). Furthermore, while positivism begun with the explicit aim to generate knowledge that will improve society and human life

(Bacon, 1967), later, positivism argued that such subjective issues must be removed from inquiry to enable the generation of knowledge that can improve them. This rendered positivism, the defender of reason and rationality, *irrational*; in fact, positivism suffer from *rationalistic neurosis* (Maxwell, 1984).

But in spite of the evidence against positivism, the research community, mostly remote from such criticisms and debates, thinks it is practicing theory, while in fact it is practicing a mix of *theoria* and praxis, and as I said previously, in an irrational manner. Partridge's (1985) analysis illustrates the mistake of the research community.

> Although the goal of *theoria* is knowledge for 'its own sake,' as the saying goes, we should also recognize that knowledge of this kind is only partly values for this reason. It is also of instrumental, pragmatic value to persons whose rank, income, and power within the college depend upon displays of certain kinds of knowledge. Outside of this interactional context the knowledge may or may not be known, pragmatically useful, or ethically relevant to anyone or any group; nor are these supposed to be important to its existence and status as knowledge within the college. On the other hand, it is impossible to ignore the fact that knowledge generated for 'its own sake' is often of interest to the Department of Defense, Standard Oil Company of California, the City Government of Atlanta, Georgia, and other tax-payers, donors, and contractors that provide funds to colleges and universities. Transmission of such knowledge to the public domain through publication or other ways is a normal function of *theoria*; the wise among us 'publish or perish' as the saying goes. (p. 143, emphasis in the original)

The dialogue

After establishing that the practice of any inquiry is a political action with ethical consequences, there arise the question, formulated by Kant, of how can reason apply to such practical actions. This question relates to the mind-body problem and although technology demonstrates its manifestation, it does not explain its possibility. The possibility of practical reason is predicated on the concept of dialogue (Bubner, 1988). One can identify at least two types of dialogues: one aiming at understanding, and another aiming at practical action. Socrates' dialogues were of the first type: they demonstrated that possessing true knowledge or understanding involve more than an exchange of words.

Dialogues aiming at actions are based on establishing and evolving a shared understanding of the values that need to guide the activities. Maxwell (1984), called for a cooperative mode of activity as the basis for achieving valued goals such as human freedom. While cooperation may be perceived as contrary to individual freedom, cooperation is both dependent on and facilitates individual freedom. The facilitation of cooperation, in spite of the logistic problems involved, should be one of the main tasks of any inquiry.

Maxwell appealed to the ideological benefit from cooperation as a facilitator and a condition of true freedom. Similarly, Habermas' earlier work on critical theory was aimed at emancipation, but his later work is aimed at developing a comprehensive social theory as a theory of communication (Braaten, 1991; McCarthy, 1978; Habermas, 1984). The main distinction from positivists theories and the theory of communicative action that is relevant to the TPP is the fact that the former replaces pre-theoretical knowledge by theories while the latter makes pre-theoretical knowledge explicit in the theory (McCarthy (1978), p. 278).

The theory of communication is developed to show how rationality is manifested in social interaction. As such, it can be critical when used to reconstruct actual history and be explanatory when it reconstructs the choices (created through some consensus building) made throughout history by various cultures. In contrast to his earlier work, the theory does not provide a therapeutic explanation (Braaten, 1991). The communicative theory encompass not only the linguistic competence of Chomsky, but also aspects of the linguistic performance or communication competence. In fact, the theory must be capable of accounting for actual communication. Furthermore, Habermas attempts to explain the current distorted situation of modern society (including the TPP) by describing it as "the result of a 'one sidedness' in the rationalization of Western societies." (Braaten (1991), p. 10) This reflect the contribution of the theory of communicative action to addressing the TPP. This contribution, however, is by no means without criticism (Honneth and Joas, 1991; Thompson and Held, 1982).

The application of reason is predicated on commitment to some standards of communication which, in turn, is inherently oriented towards mutual understanding. Habermas defined three types of arguments that are valid: theoretical, normative and aesthetical. The human capacity of communicative rational action is manifested in the ability to articulate and defend validity claims. This ability is the basis of social bond (Braaten, 1991; Habermas, 1979).

According to Habermas, communication can be rational if there is a commitment to recognize the different perspectives of people in an interaction, reflect upon them, criticize, and arrive at consensus, that is shared by all. The interaction is necessary since an individual cannot be objective about his or her experiences unless they are subjected to self reflection and collective criticism through a network of communicative actions, thereby made intersubjective.

Finally, the development of the theory is through "the theorist's participation in a 'dialogue' with the evolving culture is a two-way exchange." (Braaten (1991), p. 16) Recalling that the theory of communicative action is experimental, this dialogue may modify or invalidate the theory.

There is one more revealing view of dialogue which preceded all the above. It was Buber who in 1913 (*Daniel*) and 1923 (*I and Thou*) described three type of dialogues: (1) a *monologue* disguised as a dialogue aiming at the exploitation of one another as means to ends, (2) *technical dialogue* aimed at understanding, and (3) a *genuine dialogue* where each participants has the intention of establishing a living mutual relationship with the other (Arnett, 1986; Buber, 1958; Buber, 1964; Buber, 1972).

In the first two types of dialogues a human perceives the other dialogue participant(s) as *It*: detached and indifferent entities. This dialogue is the *I-It relation* of Buber. In the third type, a new concept emerges: the *Thou*, leading to the *I-Thou relationships*. This relationship is of different ontological significance than the *I-It* relation (Bergman, 1991). The genuine dialogue—the *I-Thou* relationship—requires a commitment to an effortful process. The essence of dialogue is the seeking for something *new*, therefore, one must actively be open to accept new ideas. A new agreement or even a disagreement may result from a dialogue, both requiring that a certain level of understanding is reached in the dialogue. This openness and flexibility means that a dialogue cannot be aimed at persuasion or delusion (Sällström, 1988), nor should a dialogue be used to reinforce old opinions: "Paradoxically, if we adopt that meaning which reinforces our preconceived opinions, 'that in which we recognize ourselves', we enter another arena - that of monologue." (Florin et al (1988), p. 24) A true dialogue means reciprocity and mutual dependence. A dialogue requires an active facilitation of the above conditions; one must be strong to resist the tendency to reduce effort, take a leisure attitude toward the world (of *It*), which do not demand the *I-Thou* tension (Bergman, 1991).

These three types of dialogue may occur in three spheres: with nature, with humans, and with spirit (Bergman, 1991; Buber, 1958).[20] For example, one can treat nature in a compassionate manner, establish genuine relationships with people, and engage in artistic creation through a genuine dialogue, or, one can use or ignore nature, be indifferent to people, and lack creativity, if one can only engage in a technical dialogue.

These three types of dialogues provide the basis for explaining the TPP. A dialogue is the ethical practice of actions, namely *praxis*. A genuine dialogue must be attached to reality and it involves an awareness of it. A dialogue lives in the present, is unique and cannot be reproduced, yet, its aim is directed at the future. A dialogue exceeds the capability of what can be formalized; its formalization reduces it to the *I-It*, to the exclusion of the possibility of

[20] One can use these three categories to modify Popper's (or Levinson's) three-world schema. Instead of having nature, human, and communicated ideas as the three worlds, the ontology consists of dialogues with these three entities. This, however, is different from Buber's existentialist ontology.

the *I-Thou* relationship. The practice of theory is a technical dialogue. Its result is science that being an abstraction of the world fails to perceive the real world (Bergman, 1991).

According to Buber, knowledge grows from alternate action and reflection, participation and distance, balance between unity and parity. No synthesis, as in the synthesis of thesis and antithesis of Hegel dialectic, is assumed. Rather the tension between these poles maintains both existence.

The evolution of methodology

Buber's concept of dialogue has a profound influence on the methodology discussed later. It is also useful for understanding the nature of this methodology or any inquiry. Analogues to the continuous interactive nature between mind and body discussed before, and the openness required in any genuine dialogue, no fixed assumption can be made about any inquiry. Inquiry is a continuous never-ending activity, one "should forever be in the process of exploring, of seeking out." (Guba (1990), p. 348). The willingness to search and reflect is crucial to coping with the changing world. Furthermore, as Toulmin (1972) said: "a man demonstrates his rationality, not by a commitment to fixed ideas, stereotyped procedures, or immutable concepts, but by the manner in which, and the occasions on which, he changes those ideas, procedures and concepts." (p. x)

It is clear that the subject matter of the inquiry changes over time: "Concepts, like individuals, have histories, and are just as incapable of withstanding the ravages of time as are individuals." (Kierkegaard, *The Concept of Irony*, cited by Toulmin, 1972, p. x). Not only the concepts of inquiry are not fixed but neither epistemology nor methodology is "about the nature of truth, but rather involves the study of the social practices by which communities develop a basis for warranted belief and action." (Giarelli, 1988, p. 26, cited by Schwandt, 1990) Similar ideas about the evolutionary nature and meaning of concepts such as induction, theory, hypothesis, empirical testing, epistemology, methodology, etc. were discussed by many others philosophers (Habermas, 1971; Peirce, 1955; Rorty, 1979).

Part II of the study discussed the TPP from the "theoretical perspective." It begun with an outline of the development of the problem, often mirroring political interests that exacerbate or conceal it. Ignoring the fundamental problems leads to explore solutions elsewhere, for example, by importing techniques from other cultures. The expected failure of these attempts forces the reconsideration of the cultural and philosophical roots of the problem.

The philosophical analysis of the TPP begins to hint at possible solutions based on restoring the full meaning of *praxis* that was degenerated to *techné*. In involves the understanding that science, technology and the solution to the problem are based on dynamic interactive social constructions. While rough solution can be outlined based on dialogue, it is not clear that it will be *welcome*.

Part III: Methodology

7 The design hypothesis

This section starts part III of the study. The previous parts established the existence and prevalence of the TPP across significant aspects of human inquiry and technology and located its development and cultural and philosophical backgrounds. This part proposes a preliminary solution path and demonstrates its use in design research and the study of technology.

The hypothesis

I start by hypothesizing that

> *humans continuously engage in designing their experiences in the world as a way of behaving.*[21]

The design hypothesis can be viewed as equating behaving with designing and interpretation. I will not try to defend this hypothesis; instead, I will use it for explaining other concepts while mentioning that others have articulated ideas about the generality of design as a human activity (Petroski, 1992), its epistemological values (Perkins, 1986), its ontological consequences (Hickman, 1990), and its existential meaning (Florman, 1976).

The design of experiences and the use of available or the development of new technology to implement them involve many people: philosophers, researchers, designers, manufacturers, distributors, and customers. All these participants engage in design. As philosophers we design arguments against and in favor of specific positions. As researchers of design, we design design-prescriptions or design tools, or study the work of human designers. As manufacturers, we design production plans and tools. As product distributors, we design lines of products, advertisements, and sales strategies. Finally, as consumers, we design our experiences and buy products that allow for their contemplation.

Traditionally, according to positivism, the participants in technological change are perceived as elements of a chain, where each link is developing a theory that the next link needs or even ought to practice. Figure 1 shows a chain with several elements relevant to the present discussion.[22] In the figure, forward arrows mean the transfer of design for implementations

[21] See note 1 on the choice of the term behaving.

[22] The extension from two to three links is mentioned by Rapp (1981): the philosopher Kapp (1877) viewed

and backward arrows mean the feedback of experience. For example, philosophers of science develop theories about how progress in knowledge accumulation is achieved and researchers are *supposed* to practice them; researchers develop design theories and expect designers to use them; and designers develop theories about what customers need and expect customers to buy their products.

Clearly the process is not always theorizing and implementation. For example, researchers do not practice methodologies developed by philosophers; rather, philosophers, such as Kuhn and Feyerabend, try to formulate descriptive theories about how science actually progresses. Nevertheless, the theory-practice metaphor unifies the relationships between all the participants in technological change. I now elaborate on the relationships between the customer, the designer, the design researcher, and the philosopher.

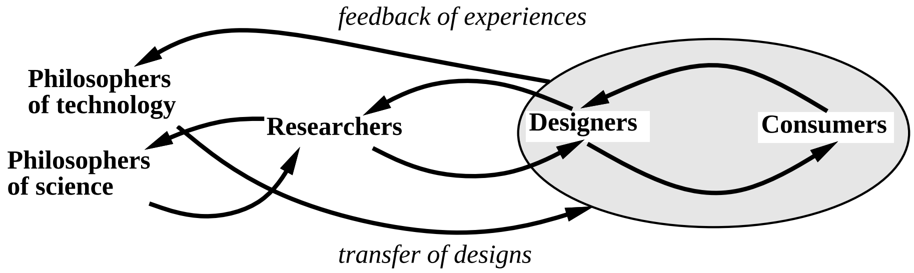

Figure 1: The theory-practice chain

The consumer engages in design; by selecting goods he or she determines his or her experiences in the world. The consumer, the last link in the technological chain, is the one that actually probes the world with the products of theories developed by remote participants in technological developments.[23] The consumer's experiences with the world can be divided into two classes of relations (Ihde, 1979): *embodiment*, manifested in acts such as driving a car that is well designed, or *hermeneutic*, manifested in acts such as driving a car badly designed. The first relation allows experiencing the world, without paying attention to the product used. the product becomes a transparent extension of the customer. In contrast, the second relation may amplify, reduce, or introduce new experiences not relevant to the original function of the product.[24] In a description

designing as imagination and a creation of an artifact as a material embodiment of the imagination; while the engineer Eyth (1905) included another phase: the successful dissemination of the artifact.

[23] Luckily, we all live in the world, and as consumers, use various tools including those we may have designed in the past. This gives researchers some leverage in getting faster feedback, than if they waited for their tools/prescriptions/methodologies to be used by others only.

[24] Recently, Winograd and Flores (1986) used similar analysis to derive guidelines for designing. Their approach, however, falls short from solving the problem of design since it maintains the control of design by designers instead

of an experience, holding a stick against a trunk of a tree, Buber's maintained that a genuine dialogue or experience require both relations, "here, where I held the stick, and there, where it touched the bark. Appearing to be only where I was, I nonetheless found myself there, too, where I found the tree. At that time dialogue appeared to me." (Buber (1964), p. 47)

The designer engages in a practice by creating designs. If the designer is fortunate, he or she enjoys this creative experience independent of its outcome; this experience is existential (Florman, 1976). Unfortunately, this experience is not free; the designer is forced to produce marketable artifacts that will maintain his or her job. Therefore, the designer turn to design "practical" artifacts. Gradually, the designer may develop an ability to enjoy the experience of designing successful products; some designers will even state that their highest satisfaction is from seeing others gain pleasure experiencing their designs. Rewards such as pay increase add to the designer's experience, but it remains fundamentally different from the existential pleasure. The concentration of designers on practical products may not be the result of their, but that of their consumers choice who by designing their experiences, drive designers towards designing specific products. The interpretation of the designer experiences as embodiment or hermeneutic is complex. The experience a designer has from building artifacts can be perceived as an embodiment relation; the experience with the design tools while designing can be perceived as a hermeneutic relation; and the assimilation of customer experiences can be perceived as a *remote* embodiment or hermeneutic relation depending on its type. A different perspective can result in different interpretations of these relations. It is almost clear that the experience through other humans create another dichotomy of relation: immediate and deferred. The deferred relation becomes hard to appreciate when approaching the left of the chain towards the philosophers.

The design researcher also produces designs: prescriptions of how design ought to be done or design tools. Although the researcher does not do it usually, he or she should also engages in designing his or her research methodology (Rzevski, 1981). Currently, funding agencies—the "customers" of research—still allow researchers to engage in "basic" research, namely, the creation of knowledge about design that, in turn, is expected to be useful in practice. As discussed in the beginning of this study, this expectation has no basis. When economy declines this fortunate situation may terminate. Therefore, researchers who design their experiences by enhancing the potential for designers' experiences, which in turn is conditioned by their customers' experiences, may have better chances of sustaining their experiental setup.

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of advocating for participation of users in design. Their problem may be the result of using the wrong ontology: Heidegger's notion of being as a human's *monologue*, instead of Buber's notion of existence as a *dialogue* between a person and its world.

Philosophers may explore the technological world via phenomenological exercises (Ihde, 1979) or other methods. Usually, their exercises will be simple or limited by current technology. Philosophers can extend their experiences by analyzing imagery situations such as those stemming from science fiction, of which Orwell's *1984* is a good example. Not only can philosophers use artifacts generated by others, but they themselves can (and probably should) actively and fruitfully engage in design activities (Sloman, 1988).

Interpretations

The unifying view of experience design provides the baseline for several interpretations of the design hypothesis. In the *utilitarian* interpretation, which is favored by positivism, the hypothesis can be rephrased as: maximizing one's own ability to design requires maximizing the abilities of the rest to design as well. The design hypothesis suggests that this goal not only requires that each participant extends and maintains his or her ability to design and carry out experiences, but that the senses from designs or experiences depend on the other participants' senses. While examples such as those described by von Hippel show that relationships of need and dependency can be explained by utilitarianism, the tendency of the utilitarians would be to maximize their utility by ignoring or exploiting others. This interpretation does not offer a solution to the TPP.

The second interpretation is *ideological*: all humans have an equal right to exercise their designs. This interpretation also addresses the ethics of design (or *praxis* in general). It is an ethics of responsibility of acting within a group context, in situations with moral ambiguities, utilizing the best tools to result morally and politically effective consequences (Partridge, 1985). While I support this interpretation, I do not expect those who prosper in the current *status quo* to shell off their privileges. In fact, with respect to researchers, I expect them to openly advocate for the same right the design hypothesis claims, but take one of at least two possible complementary positions: (1) The knowledge they generate by their "designs" is for the sake of knowledge; their activity is value-free and it is the responsibility of the one who uses it to do it "properly." (2) Society has given researchers, or more properly, "scientists," the legitimacy to find new knowledge and they only exercise their agent's privileges.

The third interpretation relies on Habermas' *communicative action* theory (Braaten, 1991; Habermas, 1979; Pusey, 1987). Since design is a social activity,[25] its conception and execution require the ability to communicate effectively. A good quality design (which is itself a concept constructed through consensus building) depends upon the ability to arrive at a consensus after arguing through raising validity claims. The quality further depends on the equal participation

[25] Even if one designs alone, the design problem posed and evolved and the values used to guide its solution are socially constructed.

of the people affected by the design. Such dependency can create a common goal, and establish a collective activity in which the facilitation of self-experiences is permitted and enhanced by others' ability to experience.

The fourth interpretation relies on Buber's notion of a *dialogue*. A true dialogue emerges when both relations: embodiment and hermeneutic exists. Through the dialogue, a unity emerges that maintains the duality of the participants (Bergman, 1991). Designing is a social process, "Man has always had his experiences as I, his experiences with others, and with himself, but it is as We, ever again as We, that he has constructed and developed a world out of his experiences." (Buber (1966a), p. 107)

Buber existentialism is significantly different from the existential nature of the engineer activities as describe by Florman (1976). For Buber, the dialogue is the condition of existence. A monologue of an engineer with his or her world may lead to the achievement goals but it cannot inject life into the engineer however pleasurable the creation may be. Therefore, the design hypothesis as a dialogue has a true existential and not just ideological meaning. The openness required in a dialogue further sheds light on the sources of creativity in design. Design as a goal-oriented problem solving is dead and routine, design as a dialogue is alive and creative.

While all four interpretations are different, the three latter share the ideological concern to equality of participation in the process of design. They share an understanding that any part of their foundations is subjected to criticism; in fact, they invite it, and on equal grounds. Their development just a process of design.

8 Implications to design research and practice

In previous sections I discussed the theoretical and political aspects of the TPP, their relations to technology and design, and the design hypothesis. It is time to put the analysis into practice and show its application to design research and practice.

First, I adopt the dualistic mind-body view and maintain it through the three analogues: mind-body, science-technology, and theory-practice. This is in contrast to the traditional positivist view which favors the contradictory materialistic-mind-body/idealist-science-technology view and the one dominating design research. This profound difference is manifested in the interpretation of the TPP.

The traditional positivist will solve the TPP by using the "market economy" paradigm. In that, researchers (designers) study the market by objectifying it via the materialistic mind-body view to find needs that require new theories (designs). Thereafter, researchers (designers) develop theories (designs), via the idealist science-technology view, that may or may not be used by designers (customers). To save themselves the burden of engaging in actions in the world in order to test their claims, researchers (designers) will isolate themselves from the market by establishing criteria for quality that are independent of market choices. Tolerating such an approach renders the solution of the TPP impossible.

The new methodology follows the dialogical interpretation, while borrowing from the communicative interpretation for supporting the former. It guarantees the fulfillment of the ideological concern and may borrow methods from the communicative interpretation. While it does not rely on the utilitarian interpretation, it promises to result in meaningful benefits for all individuals. The methodology is not a fixed one, it is not even well defined, not because the study is immature, but because it cannot be defined without practice and it can never be fixed. Nevertheless, a starting point for a methodological inquiry of design can be described and practiced. While it maintains the duality of philosophers, researchers, designers, etc., it unites them as a whole through a collaborative dialogue that enables the mutual extension of their experiences.

Figure 2 illustrates the new direction in design research and practice. The practice of design is denoted by the small dashed ellipse containing designers and customers and is called *participatory design* (Reich et al, 1992). While it has been discussed and experimented with in the last three decades (Cross, 1972; Namioka and Schuler, 1990; Rosenbrock, 1989; Sanoff, 1978), it is not prevalent as a significant way of designing. The practice of research should not be different given the design hypothesis, but except for few examples such as (Piela et al, 1992; Whyte, 1991), in an activity called *participatory action research*, participation in research is even rarer than participation in design.

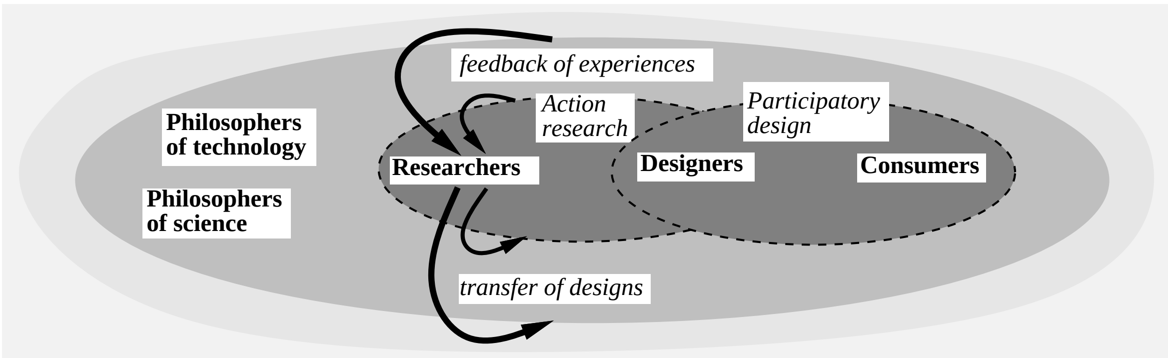

Figure 2: The theory-practice chain

Note that once we observe that each participant must become member of several collaborative activities (e.g., designers with consumers and designers with researchers), the scope of the methodology expands further. The new practice of research (design) requires that researchers (designers) expand their horizon of inquiry by studying the complete process of technological change rather than the small, isolated world of designers (consumers). Research will therefore be a *collaborative* process of researchers, designers and other relevant participants (Palumbo and Calista, 1990; Reason, 1988; Smith and Dainty, 1991; Whyte, 1991).

Ideally the scope will expand to include all participants potentially affected by a specific research or design, thereby extending the scope of any activity further into the grey area in Figure 2. Moreover, the collaborative process must consist of a genuine dialogue between all the participants, necessarily including the social impact of all activities.[26]

The participatory inquiry has several characteristics: (1) Everybody learn in the course of the inquiry. In research, researchers learn about the problem faced by designers and designers learn about what is possible, thereby allowing the reformulation of the original problem. The views, understanding, and needs of all the participants evolve throughout the research. (2) Since research is intimately linked to practice—an actual design problem—it cannot be divorced from pragmatics. Therefore, both participants make compromises in order to achieve actions. The knowledge generated from such research activity is context dependent, therefore hard to generalize. Nevertheless it is powerful to impact practice. (3) When practicing research, participants must maintain their openness about the activity, and constantly question its practical usefulness and moral appropriateness. These considerations can override the practical concerns discussed in item (2) through the participation of the customers of the products. (4) Participation means that the control of research is shared by all participants, a sharp contrast to current practice. (5) Participation means that a genuine dialogue takes place. It involves establishing a reciprocal, intimate, dependency relationships, where each participants has equal standing in the process. (6) A genuine participation must allow the alternation between action and reflection, or between relationships and space. This tension must be maintained. Therefore, participants

[26] It is interesting to see the objections professional raise about the necessity to expand the scope of design to broader issues that necessitate major participation effort. For example, a paragraph in a recent engineers' code of ethics, "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties," (American Engineerss' Council for Professional Development, 1974) stimulated discussion about its interpretation and feasibility. One objection was raised by Florman (1980).

> If this appeal to conscience were to be followed literally, chaos would ensue. Ties of loyalty and discipline would dissolve and organizations would shatter. Blowing the whistle on one's superiors would become the norm, instead of a last and desperate resort. ... Engineers can (and should) contribute to public policy as citizens, but this is very different from filtering their everyday work through a sieve of ethical sensitivity. (p. 236)

This objection redirects attention from the crucial issues of social responsibility and how it can be supported to promoting unjustified fears from chaos.

do not only build a whole, but also maintain their identity. These characteristics and others must be developed and evolve through future participatory inquiry.

Recent research in computer supported cooperative work can potentially be used in participatory activities. First, they can be developed evolutionary by participation to support cooperative work, and furthermore, they can record cooperative activities and make them available for later examinations. Such tools make sure that the ontological change of internal ideas to communicated ideas as discussed before, is not reversed. Tools that are designed to operate in this mode may formalize ideas in pre-defined data-structure and potentially extract design "rationale" from the information stored. This approach, however, does not support the ontological change that Buber describes: the change from the *I-It* relation to the *I-Thou* relationship. A tool that can potentially provide support for such change and that is currently under development is n-dim (Levy et al, 1993; Subrahmanian et al, 1991). n-dim is based on the idea that shared memory and design participation are unifying themes in design research and practice (Konda et al, 1992; Reich et al, 1992). While Konda et al. established the principle of shared memory, and Reich et al. established the role of participation in design, the discussion in this study further details the some preliminary characteristics of participation and how it may be supported.

Currently, n-dim provides mechanisms for flexibly modeling concepts at various levels using user-defined modifiable languages. The models created are stored and may be used in the future. While a limited sense of a shared memory can be evolved through the storage and manipulation of the models stored, its true creation involves a continuous dialogical process between the design participants. Communication and exchange of ideas, facilitation of incremental change and reversal of choices, are mandatory concepts that are central to obtaining a genuine dialogue between participants. While one may start creating languages that support the raising and defending of the three types of Habermas' validity claims, the participants themselves must have the ability to define, create and evolve these mechanisms through, and to further enhance, a genuine dialogue between them. The possibility of shared memory is dependent on these facilities.

Note that the use of computational support tools does not mean that the materialistic mind-body view is adopted, rather, the tools are created as *support* for human design, human interpretation of data, and human dialogue. In fact, I agree that the extensive use of computer tools may suppress designers' awareness to critical aspects of their problems (Petroski, 1992). No assumption about the general applicability of information recorded (which some may call knowledge) is made.

The evolutionary nature of design is evident. Tools that support participatory design enhance design practice, they constantly move the boundaries of what design is.[27] Therefore, the study of design will never end: good news for design researchers who will always "stay in business;" if, of course, they are willing to contribute to this change through participation.

One should make no mistakes that participation in research involves simple modifications to practice. It requires that the quality of research (and researchers) be evaluated based on the impact it leaves on practice, its political and ethical adequacy, and its contribution to the design ability of others. It prevents arbitrary questions to be explored, rather, it establishes priorities on more moral grounds to be determined by participation. Researchers will not be able to argue for their eternal role as supplier of knowledge: they will be equal participants in *praxis*.

While participation is an ideal, its actual application and its consequences are subject to experimentation and criticism. Its adoption in research must not only survive the fierce objection of positivism, but also its practical implications to the generation of good quality (in the operational and moral sense) products must be constantly evaluated. Furthermore, the concept itself may undergo revisions and even disappear, to give way to new methodologies that better address the TPP.

Finally, I would like to name the new methodology. Buber's concept of a dialogue is more revealing than the notion of participation. It is a continuous participatory process that anticipates the creation of new things, for the good of all. A dialogue that includes people and nature has the potential of designing. In general an dialogue is all that is needed to name the new approach, but I'll use a Dialogical Inquiry (DI) to further stress the creative, dynamic nature, and the seeking out properties of design.

9 Implications to technology studies

It is clear that the product of design is artifacts to which we adapt, and those that we use. These artifacts shape the environment in which we live. We not only experience nature, but also man-made objects and ideas. Nevertheless, the understanding of technology as an activity that produces artifacts falls short of conveying the structure of the activity, its meaning, and its impact on society (Mitcham and Mackey, 1972).

Mitcham and Mackey suggested that a better understanding of technology can evolve from studying it using one of three philosophically adequate approaches: anthropological, sociological, and epistemological. The anthropological approach deals with the relation of technology to

[27] The building of systems that support human capabilities, such as understanding, is an empirical study of epistemology or constitutes experimental philosophy (Arbib and Hesse, 1986). While this has always occurred in the past in an evolutionary manner, its impact is much more rapid today.

nature and man; the sociological approach deals with the relations of technology to modern society in a historical perspective; and the epistemological approach deals with the relation of technology to the structure and nature of human knowledge. A slightly different perspective of studying technology reveals three core questions related to the three above approaches. The first question is *ethical*: what is the impact of technology on society and how does the study of technological change it? The second question is *practical*: what is the product of the study of technology? The third question is *methodological*: how do we study technology and how does it affect our chances to answer the these three questions?

The ethical question concerns basic studies on the personal and social impacts of technology (Bender, 1987; Brown, 1971; Mitcham and Mackey, 1972) and also addresses new ethical problems emerging from technological progress, such as the need to reformulate life or death issues in light of new life saving devices (Ihde, 1979), or the need to study the issue of professional ethics in various disciplines (Durbin, 1987).

I propose that a crucial question to be addressed is how technology affects human ability to participate in a genuine dialogue. Bergman (1991) clearly interpreted Buber on this subject.

> A technological summit has been reached in our time, yet technology was developed at the expense of human relationships:
>
> > The improvement of the capacity for experience and use generally involves a decrease in man's power to relate—that power which alone can enable man to live in the spirit ([Buber, 1964,] p. 89)
>
> When the spirit loses its power, the terror of the It, the fear of the world of objects and the horror of the atom bomb assail man. (p. 235-236)

Arnett (1986) also provided a similar interpretation of Buber on the impact of technology on human ability to follow the "narrow ridge" way. The further study of this impact of technology is central to answering other ethical questions concerning technology.

Common products of an inquiry, including technology studies, are often described as: knowledge, readily usable production procedures, artifacts, awareness to ethical issues, etc. These products, however, have too much pragmatic connotation, once they are distilled from the processes and contexts that generated them. I argue that an important product of technology studies should be an evolving concept of how a genuine dialogue can be established, supported, and enriched.

The methodological question deals with the procedure of studying and recognizing technological progress. The answer to this question influences the way the practical, the ethical questions, and even this question itself are addressed. Buber's dialogue as discussed in the previous section provides the basis for an activity that has a great promise of addressing the crucial problems of technology.

There is a hidden circle in the three questions concerning technology. The methodology is predicated on dialogue, the product is defined as a better understanding of how genuine dialogues can be facilitated, and the ethical concerns is addressed by demanding the existence of a genuine dialogue whose practice is to be evolved. It should not be surprising to find such a circular dependency. Technology constantly changes the environment, we find ourselves experiencing new sensations and adapt to new circumstances. Therefore, technology necessarily engages us in self-creation (Feibleman, 1982) that constantly circles through design, experience, and adaptation activities.

Buber's dialogue is a whole that addresses at least three of the core concerns of technology. Arnett (1986) had described it as a Copernican revolution: shifting from an "internalized and possessive view of communication to a narrow ridge perspective." (p. 57) While I only briefly touched its implication to understanding technology, Arnett elaborated on its implications to contemporary technological society. The meaning and implications of the dialogue are by no means exhausted and deserved further examination.

10 Predictions and summary

In this paper, I have tried to elaborate on the TPP of design and technology and propose a research methodology that addresses it. I can use the design hypothesis and the concept of dialogue to summarize the study from a different perspective. Part I demonstrated the unfortunate status of the TPP, imposing unwarranted constraints that limit or deprive people from designing, executing, or interpreting their experiences. Furthermore, the TPP prevents people from engaging in genuine dialogues. Some people (as participants in some aspect of technology) may feel being, but all are implicitly, in an *oppressive, limiting state.* Part II elucidated the background of the problem mainly focusing on the recent development of the problem and its ties to culture and philosophical thought. It demonstrated the severity of the problem and its resistance to simple solutions. Part III illustrated a methodology that can emancipate from the present situation. Since the methodology is itself a design about how design should be executed, it is reflective and invites criticism.

The new methodology will not disseminate easily. It threatens to remove sources of power that some people enjoy as summarized by Guba (1990).

> *Power and politics will play an important role as the paradigm dialog unfolds.* When I used the term *hegemony* earlier, in suggesting that power has passed from positivists to postpositivists, I meant to state forcefully that there is a great deal more at stake in the paradigm dialog than simply a debate over a few conceptual issues. *Hegemony* implies *least* control over appointment, promotion, tenure, publication, legitimation, status, training, accountability, funding, research agendas, and myriad other factors that determine the quality of our professional lives. (Guba (1990), p. 375; emphasis in the original)

In this paper I chose to follow a different approach than that described by Bernstein (1983). He explained that

> because philosophers like Rorty and the edifying thinkers that he admires see the trap of trying to *prove* that the objectivist is fundamentally mistaken, they employ a form of indirect communication and philosophic therapy that is intended to loosen the grip that objectivism has upon us—a therapy that seeks to liberate us from the obsession with objectivism and foundationalism. (p. 9)

While I acknowledge the same trap, I selected the method of direct criticism. I have referenced many philosophers and practitioners discussing the TPP and their proposed solutions, some of which have been put to successful preliminary practice; while other solutions, proposed from within the positivist camp, are bound to fail. These references should demonstrate the breadth and depth of the manifestation of the TPP. In choosing the direct criticism approach, I have already violated the concept of participation, let myself be driven by the ideological value of participation, hence opening the avenue for criticism on that account. In spite of this violation, I hope that a genuine dialogue can still proceed and I predict that it will. This prediction, in turn, completes the requirements for participation in research or dialogical inquiry to be a critical theory (Geuss, 1981).

I can be mistaken in the design hypothesis or in any of its consequences since none of its interpretations can be proved. On the other hand, they cannot be disproved. In any case, any opposition will have to locate the disagreements at the foundation level, rather than at the details of a specific research project. Such critical level will promote fruitful dialogue on the presuppositions of opinions. Thus, even if the methodology proposed will be reformulated, as it will, the critical theory programme will survive.

Finally, this paper, including the research methodology I have outlined, is a design of a "narrow-ridge" (Buber, 1966b) for a dialogue. Its value depends on the experiences and actions it elicits from its readers and not on its eternal existence or truth value; for as a design, it is bound to have a limited life-span. My hope is that the experiences it elicits will serve to approach *The Third Alternative*:

> In the most powerful moments of dialogic, where in truth "deep calls unto deep," it becomes unmistakably clear that it is not the wand of the individual or of the social, but of a third which draws the circle round the happening. On the far side of the subjective. on this side of the objective, on the narrow ridge, where I and Thou meet, there is the realm of "between."
>
> This reality, whose disclosure has begun in our time, shows the way, leading beyond individualism and collectivism, for the life decision of future generations. Here the genuine third alternative is indicated, the knowledge of which will help to bring about the genuine person again and to establish genuine community. (Buber (1966b), p. 55)

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