Appropriating Technology: an introduction

Most social studies of science and technology have focused on either production by established professionals, or the impact on the general public. But what about the lay public as *producers* of technology and science? From the vernacular engineering of Latino car design to environmental analysis among rural women, groups outside the centers of scientific power persistently defy the notion that they are merely passive recipients of technological products and scientific knowledge. Rather, there are many instances in which they reinvent these products and rethink these knowledge systems, often in ways that embody critique, resistance, or outright revolt. This book presents the first collection of case studies of such appropriated science and technology. For shorthand we will refer to these as "appropriated technologies," but keep in mind that they are often as much about scientific knowledge and ideas as they are about gadgets and technical methods—that is, they encompass the entire realm of "technoscience".[1]

1) What are Appropriated Technologies?

Sociologists, anthropologists, historians, and other researchers have recently converged in a new field termed "Science and Technology Studies" (STS). Many of these studies have been framed in terms of "social impact," examining how science and technology change our personal lives or cultural attitudes or environment. Another approach to STS, dating back to the work of Robert Merton in the 1930s, studies science itself as a social phenomenon. Recently this has produced some heated debates about just how much social processes actually influence scientific and

technological research. Other STS research clusters have been built around policy studies, ethics and values in science, anthropology of medicine, etc.

Despite this diversity of approaches, the vast majority of these studies focus on the professional as the producer. This approach is so frequent that alternatives can be easily overlooked. As social scientist Manuel Castells suggests, one way to make the relations between society and technoscience more visible is to think about a “space of flows” in which we map not just geographic locations, but the networks of information and paths of material transport that increasingly define a knowledge-based economy. Here we will extend visualizations of this space of flows to even more intangible attributes of people and power—not as a way to reduce social dynamics to a single point of view, but rather the opposite, to expand our ability to understand appropriated technologies from a greater variety of perspectives.[2]

Figure 1 shows how the standard view of science and technology might be visualized. On the vertical axis we have “social power,” with some well-to-do professionals at the top, and some hard-knock blue collar folks at the bottom. Granted, there are hundreds of different aspects of social power; some obvious such as financial assets, political legitimacy, or religious

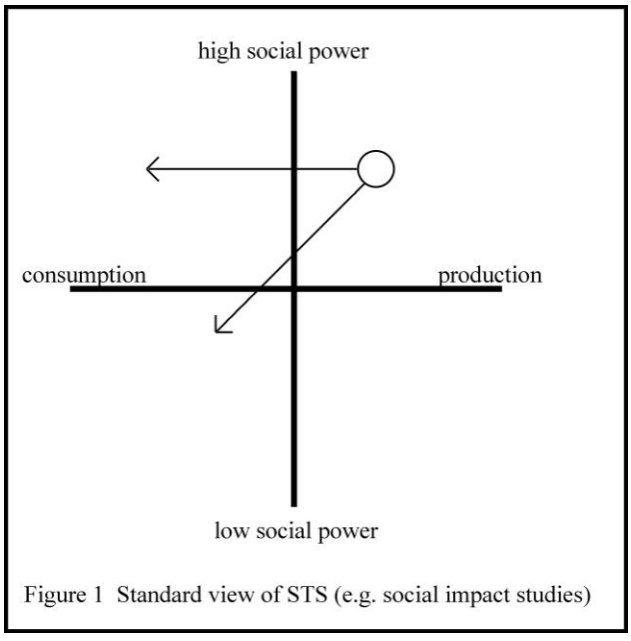

Figure 1 Standard view of STS (e.g. social impact studies)

authority; and some more subtle, such as the often unconscious bias against personal appearance
(ethnicity, gender, age, beauty) that can emerge in even the most nondiscriminatory of circumstances. Moreover, these different aspects of social power can conflict with each other. A penniless prophet might hold thousands in his sway, while a lonely rich atheist might mold society by money. So when producing this type of graph, we need to remember that there are many different ways each a single case study could be drawn, depending on the focus of the analysis.

Let's assume that we have agreed upon some particular category or dimension of social power, such as income, which lands our scientists or engineers in this study towards the upper half (something like upper-middle class). Now we want chart the flow of artifacts or ideas as they leave the laboratory and find their way to consumers. For this task we will need the horizontal axis of figure 1, the production-consumption axis. Again, there is no reason to think of this single dimension as simultaneously representing the hundreds of different consumption/production aspects of our lives; we take it that the graph is only trying to show a single aspect of one product. If we divide our consumers into two groups—the rich and the poor—then we would have two paths from the professional producers, as shown in figure 1. Of course the graph is only indicating the general direction of the flow in terms of these two dimensions; in physical time and space these paths might be quite complex, with knowledge that slowly diffuses to the public, or circuitous routes from design lab to factory floor to shops to home (cf. Cowan 1987).

Even with such a simplified view, there are many instances which it do not fit this picture. The best known are those of the ethnosciences; for example ethnomathematics or ethnobotany (figure 2). An indigenous society may be at the margins of political and economic power, but their knowledge systems can produce information that winds up in a first world high-tech laboratory.

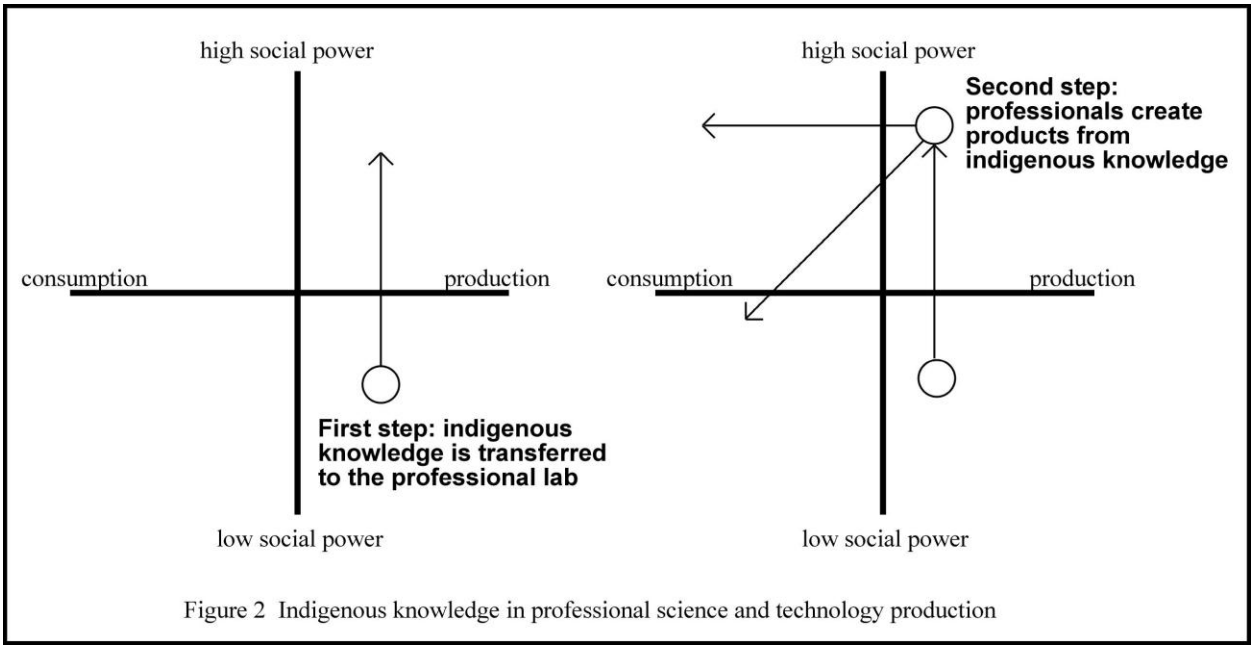

Figure 2 Indigenous knowledge in professional science and technology production

Through ethnopharmacology, for example, indigenous herbal cures can lead to high profits in the biotechnology industry. Of course that doesn't necessarily mean high profits for the indigenous herbalists -- in fact, their knowledge is often appropriated without compensation.

Appropriation, however, can be a two-way street, and it is the traffic in the opposite direction that concerns us. The case studies presented in this book show how people outside the centers of social power -- from white middle-class homemakers to rural

Native Americans -- have been able to use materials and knowledge from professional science for their own kinds of technological production. In these appropriated technologies (figure 3), we begin with production at the usual professional locations, but it is followed by a second phase in which this technoscience is reinterpreted, adapted, or reinvented by those outside these centers of power. Of course the trajectory need not stop there. Such innovations can reappear in professional contexts, mix with indigenous knowledge, and enter into further appropriations from either top or bottom.

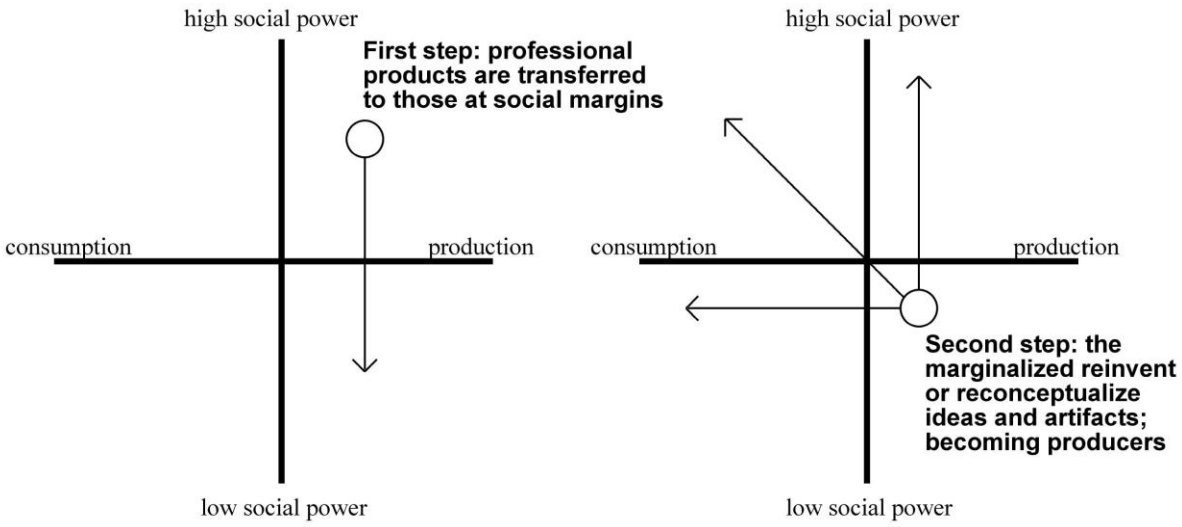

Figure 3 Appropriation of science or technology by those at the margins of social power

2) Why study appropriated technologies?

Many of the researchers in social studies of science have entered the field because of their concern over the real and potential dangers involved in science and technology. For this reason the field has gain a reputation for pessimistic views, and critics sometimes accuse them of being technophobes or luddites. Appropriated technologies

offer a rich resource for combining a critical analysis of social issues with an eye towards the positive application of science and its artifacts. Of course not all of these case studies are happy stories: neo-nazi groups are also outside the centers of scientific production, and they too adapt and reinvent to gain power. The stories of technological appropriations are multifaceted; they are both painful and joyous, reassuring and shocking. They are complex enough to warrant study for their own sake. But their primary importance is in their potential contribution to socio-political resistance and social reconfiguration.

3) Variations along the consumption-production dimension

In collecting the various case studies for this anthology, it became apparent that some examples made a stronger case for appropriation than others. Using that distinction, we developed the following three analytic categories, positioned along the consumption/production axis (figure 4).

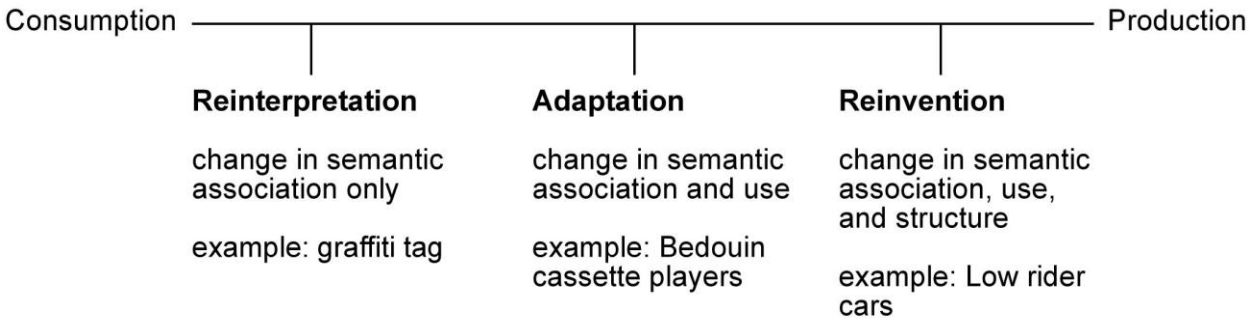

Figure 4: The consumption-production dimension

The weakest case, reinterpretation, is defined by a change in semantic association with

little or no change in use or structure. Graffiti tags are a good illustration: the physical and functional aspects of a building are essentially unchanged, but the semantic claim to possession, as a form of either cultural resistance or criminal turf war, is not trivial (Castleman 1982, Rose 1994). The next stronger case, adaptation, is defined by a change in both semantic association and use. For example, the Bedouin society of Egypt, a relatively disempowered ethnic minority, found that cassette tape players, which were marketed for listening to music from the Egyptian majority, had an unused recording capability as well. They began to record their own songs, and this eventually led to the rise of a Bedouin pop star and the creation of new economic and cultural opportunities (Abu-Lughod 1989). Adaptation requires two technosocial features. First, an attribute of the technology-user relationship that Hess (1995) refers to as "flexibility."[3] For example, a calculator is less flexible than a word processor, which is less flexible than a personal computer. Second, it requires a violation of intended purpose. It is a mistake to reduce this to the intentions of designers; we also need to consider marketing intentions and "common-sense" or popular assumptions. In the case of Bedouin cassette players we have a pre-existing flexibility for recording that was intended by the designers, but this was obscured by the marketing focus on play-back only. Adaptation can be described as the "discovery" of a "latent" function, but that definition needs to be problemitized in the same ways that philosophers have debated whether mathematics is invention or discovery (Restivo et al 1993). The creativity required to look beyond the assumed functions of the technology and see new possibilities is a powerful force for social change, yet one that receives insufficient theoretical attention.

The strongest case for appropriated technology is reinvention, in which semantics, use and structure are all changed. That is, if adaptation can be said to require the discovery of a latent function, reinvention can be defined as the creation of new functions through structural change. Low-rider cars (figure 5) provide a clear demonstration of this combination. Although automobile shock absorbers were originally produced for decreasing disturbance, Latino mechanics developed methods for attaching them to electrically controlled air pumps, turning shock absorbers into shock producers. Low-rider cars violate both marketing and design intentions, but the new functionality was introduced by altering the original structure, rather than discovering functions lying dormant in the original artifact.

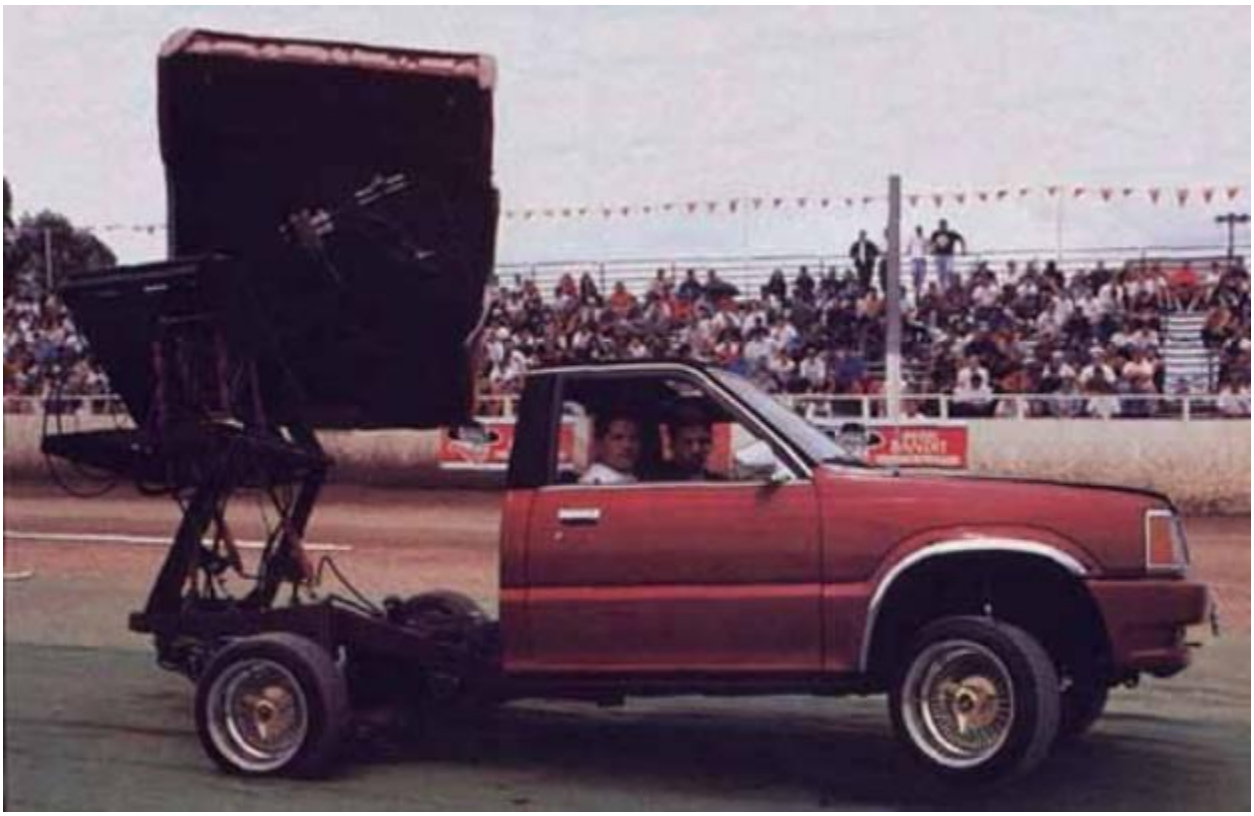

Figure 5: Joe Grosso's Mazda, "Desirable Ones." Copyright Lowrider Magazine, use by permission only

It is important to understand that in distinguishing strong versus weak cases for appropriated technology, we make no evaluation of ideology or effectiveness. One might, for instance, find more political success with reinterpretation than reinvention in a given case. But the three categories do offer a useful set of analytic distinctions. Consider, for example, Native American artist Sharol Graves' description of the genesis of her work (figure 6):

> The image of these serigraph prints started out as a joke. When I worked in the silicon valley, I used to draw on the computer during my lunch hour. I made the computer do things the software wasn't designed to do. I would draw for an hour and save my "Indian design" drawing. Then the computer would crash because of a memory overload. Then, I had to figure out a way to save it another way. When I finally tried to plot out the design on a D-size drafting plotter, I ran into a similar problem. Once again, I was able to figure out a way to manipulate the plotter to draw the entire image (Graves 1995).

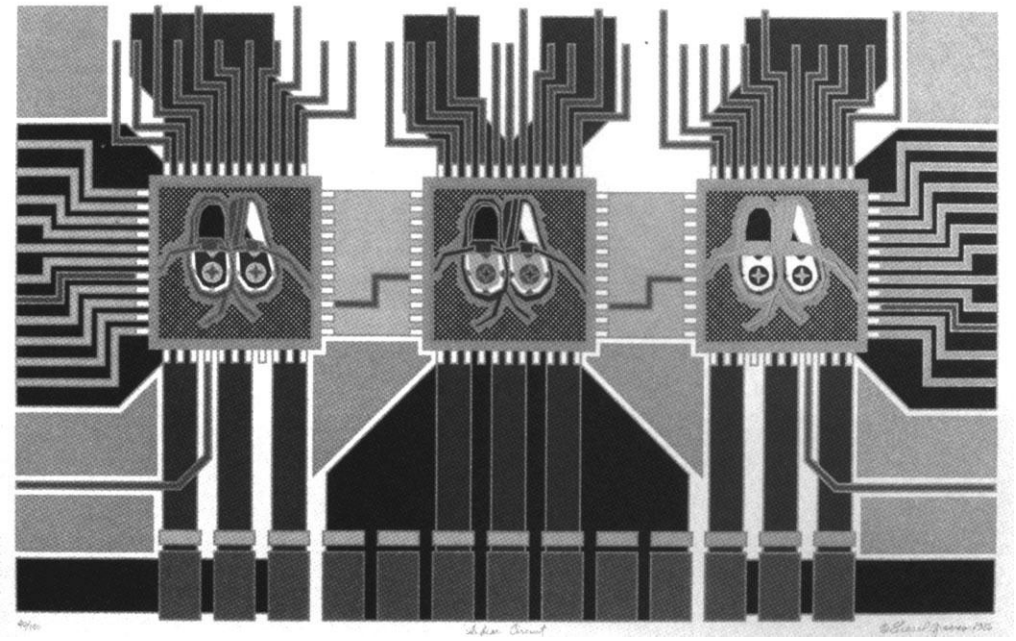

Figure 6: “Indian Circuit” by Sharol Graves, 1986

Graves first reinterpreted the CAD/CAM software for circuit design as an artistic medium; she then adapted it for new functionality, and finally reinvented the system, changing its physical capabilities. She explains, “I wanted the public to know that a Native American was working in the research and development of high technology, just to blow a few stereotypes about the ‘Indian Mind.’” For Graves the activities of reinterpretation, adaptation, and reinvention map out a journey that progressively fused cultural and electrical resistance.

4) Variations along the social power dimension

In considering variation along the social power dimension, we need to steer between two potential pitfalls. On the one hand, we need to avoid multiculturalist relativism, in

which every social group is seen as just another dish in the global smorgasbord (Fraser 1997). On the other hand, we need to avoid a contest for victimhood; we don't want to construct a hierarchy of oppressions. One way to avoid this dilemma is to keep in mind the multidimensional nature of these categories of social power; as noted earlier each case could be mapped in several different ways. But even if we reduce our analysis to one dimension – say, for example, racial/ethnic identity -- both groups and individuals must be approached in historic, contextual terms, not as a fixed "essence." Indigenous ("fourth world") societies, for example, can be endangered by the descendants of colonialists, but many of these descendants are themselves ethnic hybrids seeking to contest their own marginal "third world" status. Analyses of appropriated technologies need to consider the historically specific relation between these cultural locations, and the turbulent mixture of people, artifacts, techniques and texts that make up technoscience.

Consider, for example, the famous case of Kayapo video (Turner 1992). Deep in the Amazon rainforest, the construction of a hydroelectric dam threatens Kayapo lands. The Kayapo use handheld camcorders; at first to rally support in dispersed villages, and later to help document their protest. Despite the Brazilian government's interest in keeping the activism quiet, the images are picked up by the first world press, showing the Kayapo in full war regalia with bright tropical bird feathers juxtaposed against the high-tech camcorders. What could have been an obscure protest becomes an international media event, resulting in political pressure to stop the dam. But how should this be analyzed in regard to appropriated technologies? In one sense, the

Kayapo are merely using camcorders the way the Sony corporation intended: to make videos. In terms of the consumption-production dimension, it is quite weak. But the Kayapo are not the typical consumer that the Sony engineers had in mind when they created this technology.

First world consumers, especially those from the white middle class, rarely realize the extent to which their technological access is ensured simply by their status as "the user" foremost in so many designers' minds. For example, even something as seemingly universal as photographic film embodies decades of chemical refinement using white-skinned models; similar phenomena exist for furniture, clothing, and many other products.[4] When we think about the dimension of consumption/production, we need to keep in mind that some consumers have flows of access to the "production" end of the spectrum that are normally invisible, even to themselves.[5] In the case of Kayapo video those paths are nonexistent; merely the fact that they were able to translate use of this technology from the first world context in which it was designed (a context which assumes, for example, that there will be electrical outlets with stable power sources available) to the fourth world context of indigenous artifacts and knowledge is in itself an impressive appropriation accomplishment. In other words, movement across the dimension of social power is just as important in defining appropriated technologies as movement across the consumption-production dimension.

Thus we should think of our graph not as a static map, but as a place to chart the movements of artifacts, ideas, and even people. Movements make visible the contours

of social power in relation to technoscience: we sense the difficulty of movement in the "wrong direction," the resistance we encounter when these artifacts, ideas and people try to flow upstream. We can visualize this difficulty or resistance to uphill flow on our graph by adding a third dimension (figure 7).

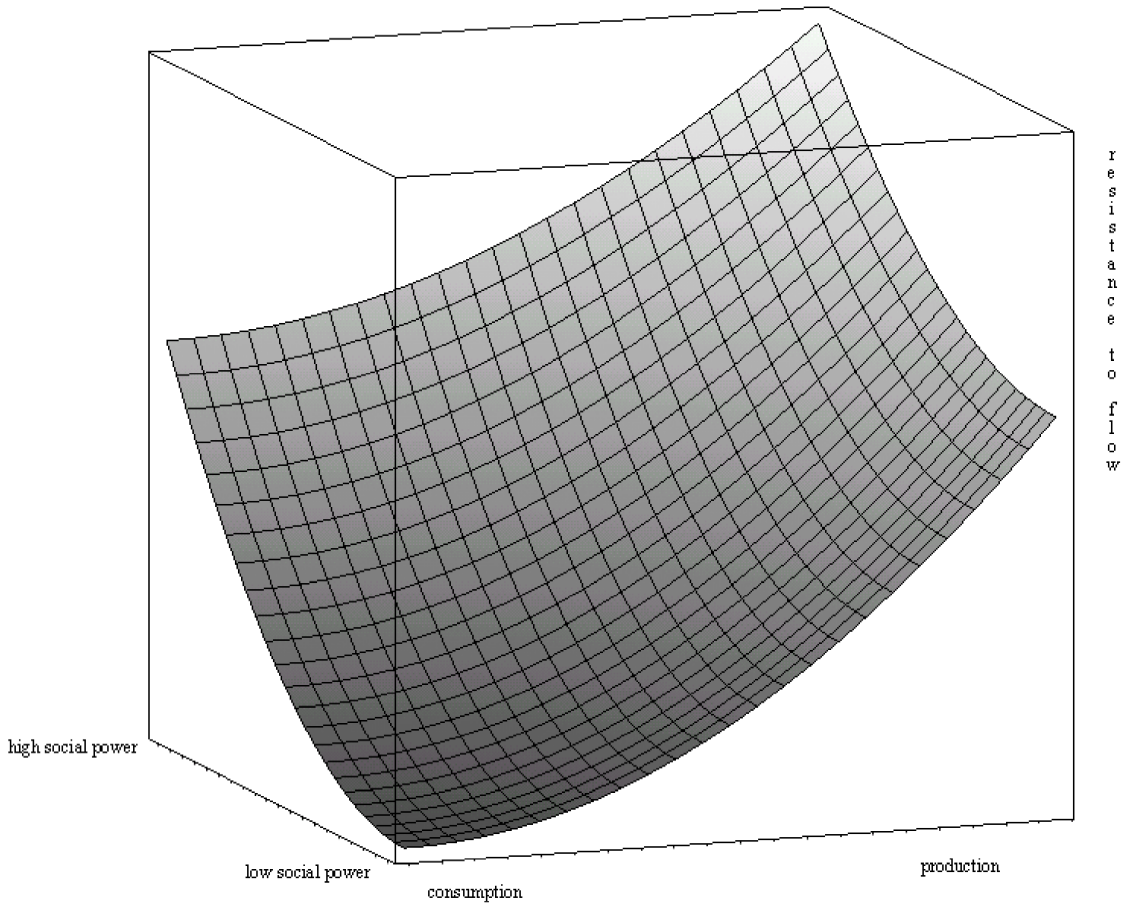

Figure 7: The uphill struggle to appropriate science and technology

When I mention appropriated technologies to political conservatives, they sometimes

respond with a Horatio Alger story: “technology lets anyone pull themselves up by their own bootstraps.” Figure 7 helps to visualize the critique of that myth: a portrait of the forces that unite elite social power and technoscience production, and of the pull that keeps disenfranchised groups away. Working class students struggling in school, for example, often describe their troubles in terms that sound like bad luck—“missed my exam because I had to take my brother to the hospital” or “my car wouldn’t start”—but when we step back and view the whole of such incidents we can see them like iron filings in a magnetic field, mapping out flows of power.[6] As cultural theorists such as Michel Foucault and N. Katherine Hayles have pointed out, social power can be so diffuse that it acts more like a force field in physics, a volume filled with electrical or magnetic or gravitational vectors. And that too is an appropriation; we need new kinds of literacy that allow more non-scientists to understand and shape the contours of this multidimensional space of flows.

5) A brief survey of previous research

Unlike this anthology, the word “appropriation” in STS literature typically refers to the context of professional scientists and engineers, such as the Marxist critique of the appropriation of labor by the upper class, or the complex portrait recently offered in Hård and Jamison’s anthology titled The Intellectual Appropriation of Technology, which describes how professionals have used technology for purposes of romanticism, nationalism, etc. But the appropriation of science and technology by marginalized groups, as we have defined it here, is a more widespread phenomenon. The following seven categories describe how some of this research has been conceptualized.

a. **The consumption junction**. Cowan (1987) charts the relations of consumption and production in the history of cooking stoves, using innovative diagrams that work like topological maps to show the collective force of consumers in shaping technology design through market demands (see also "evolutionary economics," e.g. Dosi et al 1988). Mackay and Gillespie (1992) and Lie and Sorenson (1996) extend this analysis to user adaptation through more detailed examples. Smith and Clancey's (1998) anthology includes a collection of essays on "hobbyist worlds" of innovation, such as Douglas' study of the extraordinary role played by early amateur radio operators.

b. **Vernacular knowledge systems**. Vernacular architecture has long been a subject of interest in folk arts and anthropology, particularly where "high culture" components are reassembled into "low culture" structures. Vernacular mathematics is described by Nunes et al (1993) and Lave (1988), and both Eglash (1995) and Darrah (1995) describe adaptations in information technology that can be termed vernacular cybernetics. Akrich (1992) analyzes vernacular engineering of energy generation in third world development, and demonstrates how differences in both technical flexibility and cultural context influence adaptation. Pacey (1983) on "Eskimo" adoption of snowmobiles, Manuel (1993) on cassette use in India, and Gupta (1998) on selective synthesis of indigenous and high-tech agricultural knowledge are all good examples of such vernacular appropriation. Appadurai (1996) and Escobar (1995) discuss some of the broader cultural politics of technological hybrids.

c. **The ambiguity of use**. Westrum (1991) describes how the “ambiguity of use” invites adaptation and tinkering. “A device is basically a solution, but there may be more than one problem to which it applies” (p. 239). Tenner (1996) provides an analysis of the “unintended consequences” of technology, such as the dialectic between changes in sports technology and changes in sports activity.

d. **Creative misuse**. Penley and Ross (1991) note several cases of “popular refunctioning of foreign technology” such as “the Vietnamese farmers who turn bomb craters… into fish ponds” (although they curiously disregard these as merely “cute” examples, preferring information technology as a more explicitly oppositional political appropriation of technology). Terry and Calvert (1997), focusing on gender, point to groups such as the Barbie Liberation Organization, which switched voice recordings for Barbie dolls and G.I. Joe and slipped them into stores across the nation, to emphasize the intentionality of what Terry calls “creative misuse.” On a less political note, Hesser (1998) describes the wide variety of culinary innovations, from a panty hose consommé strainer to cedar roof shingles for salmon.

e. **Public understanding of science**. Toumey (1996) points to several examples, such as evolution versus creationism, the fluoridation debate, and other public controversies in which the authority of science is brought to play against itself. In the hands of popular groups such debates at times appropriate science using rigorous data and analysis, and at other times are merely “conjuring” the effect of science using its symbols. Irwin and Wynne’s (1996) anthology emphasizes the appropriation aspects of certain lay interpretations.

f. **The outsider within**. Collins (1987) describes the multiple and sometimes

conflicting positions for African American women as “the outsider within.” This framework in which personal identity and professional identity lie at opposite ends of the social power axis is descriptive for many situations in which marginalized groups move into professional science and technology production. Examples include Manning’s (1983) study of anti-racist biologist E.E. Just, Koblitz’s (1983) biography of feminist mathematician Sophia Kovaleskaia, and others whose upward mobility did not erase an “oppositional consciousness” (Sandoval and Davis 2000).

6) The role of appropriation in democratizing science and technology

Appropriated technologies do not have an inherent ethical advantage. First, insofar as appropriation is a response to marginalization, we should work at obviating the need for it by empowering the marginalized. Second, not all forms of resistance are necessarily beneficial in the long run. Aihwa Ong, for example, notes that Malaysian women using spirit possession as resistance to exploitation may be releasing frustrations that could have gone into collective labor organizing. And as we noted, white supremacist groups might well be described as marginalized people who appropriate the internet and other technologies. While free speech must be preserved at all costs, appropriation is not an ethical win in the case of neo-nazi web sites.

Insofar as science and technology appropriations do have potential contributions to stronger democracy (cf. Winner 1986, Sclove 1995, Schuler 1996), we need to understand how these positive attributes can succeed. First, there are obstacles to appropriation itself; most obviously those created by totalitarian governments, but

corporations can also dampen or discourage appropriation. The flexibility required to allow user adaptation, for example, is increasingly threatened in contemporary information technology marketing strategies. The best known case is Microsoft's attempts in securing market shares by preventing inclusion of the Netscape web browser, but this strategy of selective compatibility is much more widespread. For example, during the web browser court inquiry, it was revealed that Microsoft had prevented its competition from gaining complete knowledge of all Windows OS files, which would mean that Microsoft's own application software would be more reliable than that of its competitors. Encouraging designers to incorporate appropriation as a positive virtue means reversing this trend towards inflexibility. Of course flexibility itself can be a means of social dominance, as Martin (1994) points out in examining concepts of the embodied self under capitalist relations of "flexible accumulation" (eg flexibility as a managerial strategy). Extending Martin's framework to technology design, we might point to the ways in which the increasing flexibility of software allows it to adapt to individual users' computers, making internal changes to its software configurations, linking automatically to company websites and engaging in other activities that blur the line between "enhancement" of user capabilities and a prosthetic for corporate influence.

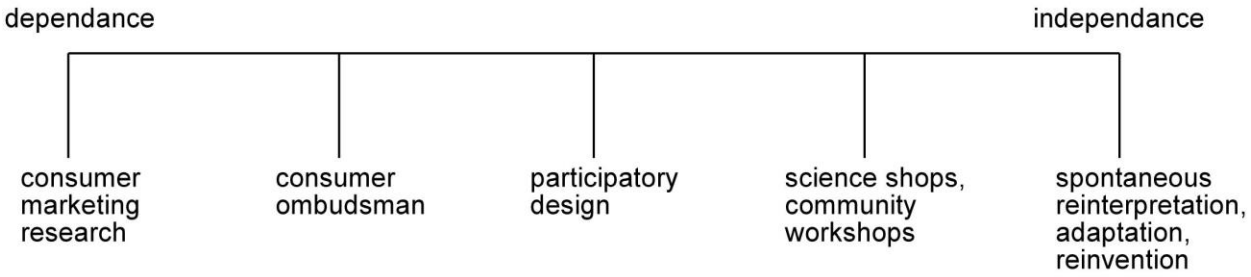

Figure 8: The spectrum of dependance-independance for appropriated technologies

Second, we can examine each case of lay/professional relationship in terms of the dependence or independence fostered by various appropriated technology strategies (figure 8). Rather than romanticize independence, both users and designers should strive towards the method of appropriation that will move toward strong democracy their particular context, while allowing for changes such as increasing independence to free up new possibilities, or decreasing it to facilitate institutionalization.

Finally, we can encourage, inspire, and incite the use of appropriated technologies for opening new possibilities in the relations of culture and science. Foucault's powerful phrase, "technologies of the self," only uses technology in a metaphorical sense, and is focused on self-making by those at the high end of the social power spectrum, but de Lauretis' Technologies of Gender brings the apparatus of representation together with discussion of its marginal actors in ways that suggest both the challenge and promise of appropriation for cultural identity. We need not just more cultural expertise in technical matters, but more syncretism in both directions. We need not only more scientific access for local communities, but more cultural workers -- artists, writers, activists and

others -- who can animate the spirit of technoscience, and speak to the soul of appropriated technologies.

References

Abu-Lughod, Lila. "Bedouins, Cassettes, and Technologies of Popular Culture." Middle East Report (July-August), pp. 7-11, 47, 1989.

Akrich, M. "The de-scription of technical objects." Pp. 205-240 in W.E. Bijker and J. Law (eds) Shaping Technology/Building Society: Studies in Sociotechnical Change. Cambridge: MIT Press 1992.

Anderson, Philip W., Arrow, Kenneth J., and Pines, David (eds). The Economy as an Evolving Complex System. Addison Wesley Longman 1988.

Appaduri, A. (ed.). The Social Life of Things: Commodities in a Cultural Perspective. Cambridge: Cambridge University Press 1986.

Appadurai, A. Modernity at large: Cultural dimensions of globalization. Minneapolis: University of Minnesota Press 1996.

Castells, Manuel. The Rise of the Network Society. Malden, Mass: Blackwell 1996.

Castleman, Craig. Getting Up: Subway Graffiti in New York. Cambridge: MIT Press 1982.

Collins, H.M. “Knowledge and controversy.” Social Studies of Science 11:3-10 (1981).

Cowan, Ruth Schwartz. “The consumption junction: a proposal for research strategies in the sociology of technology.” Pp. 261-280 in Bijker, Wiebe E., Hughes, Thomas P., and Pinch, Trevor J. (eds) The Social construction of technological systems : new directions in the sociology and history of technology. Cambridge, Mass. : MIT Press, 1987.

Darrah, C. N. (1995). "Techno-Guanxi: Connecting Relationships and Icons Through Technology." Paper presented at American Anthropological Association annual meeting, Washington, D.C., 1995.

de Lauretis, Teresa. Technologies of Gender. Bloomington: Indiana University Press 1987.

Dosi, G. et al. Technological Change and Economic Theory. New York: Pinter 1988.

Eglash, R. "African influences in cybernetics." in The Cyborg Handbook, Chris Gray (ed), New York: Routledge 1995.

Escobar, A. (1995). Encountering development: The making and unmaking of the third world. Princeton: Princeton University Press.

Fang , Irving. A History of Mass Communication : Six Information Revolutions. Boston Focal Press, c1997.

Foucault, Michel. Discipline and punish : the birth of the prison (trans. Alan Sheridan). New York: Vintage Books 1979.

Foucault, M. (1988). “Technologies of the self.” In L. Martin, H. Gutman, & P. Hutton (Eds.), Technologies of the self: A seminar with Michael Foucault (pp. 16-49). Amhurst, Mass.: University of Massachusetts Press.

Fraser, Nancy. Justice Interruptus: Critical Reflections on the 'Postsocialist' Condition. New York: Routledge 1997.

Graves, Sharol. “Indian Circuit.” In Sara Bates (ed) Indian Humor. SF: American Indian Contemporary Arts 1995.

Gupta, A. (1998). Postcolonial developments: Agriculture in the making of modern India. Durham: Duke University Press

Hess, D. Science and Technology in a Multicultural World. (Columbia University Press 1994).

Hesser, Amanda. “Quick, Hide the Tools. Here Comes a Chef.” New York Times, pg 1 of Dining In, Dining Out/Style Desk, September 16, 1998.

Irwin, Alan and Wynne, Brian. Misunderstanding Science? Cambridge: Cambridge University Press 1996.

Koblitz, Ann Hibner. A Convergence of Lives : Sofia Kovalevskaia : Scientist, Writer, Revolutionary. New Brunswick, NJ: Rutgers Univ Press 1983.

Latour, B. and Woolgar, S. Labotory Life. Princeton: Princeton University Press, 1979.

Lave, J. Cognition in Practice. New York: Cambridge University Press 1988.

Lie, Merete and Sørensen, Knut H. (eds) Making technology our own? : domesticating technology into everyday life. Oslo: Scandinavian University Press, 1996.

Mackay, Hughie and Gillespie, Gareth. “Extending the social shaping of technology approach: ideology and appropriation.” Social Studies of Science 22:685-716 (1992).

Manning, Kenneth R. Black Apollo of science : the life of Ernest Everett Just. New York : Oxford University Press, 1983.

Manuel, P. (1993). Cassette culture: Popular music and technology in north India.

Chicago: The University of Chicago Press

Nelson, R. and Winter, S. An Evolutionary Theory of Economic Change. Cambridge: Belknap Press 1982.

Nunes, Terezinha, Schliemann, Analucia Dias; and Carraher, David William. Street mathematics and school mathematics. Cambridge: Cambridge University Press, 1993.

Oudshoorn, N., United we Stand: The Pharmaceutical Industry, Laboratory, and Clinic in the Development of Sex Hormones into Scientific Drugs, 1920-1940. Science, Technology & Human Values, Vol.18, nr.1, 1993: 5-24.

Ong, Aihwa. Spirits of resistance and capitalist discipline : factory women in Malaysia. Albany : State University of New York Press, 1987.

Pacey, A. The culture of technology. Cambridge, Massachusetts: The MIT Press 1983.

Penley, Constance and Ross, Andrew. Technoculture (ed). Minneapolis: University of Minnesota Press, 1991.

Pinch, Trevor J. and Bijker, Wiebe E. “The social construction of facts and artifacts: Or how the sociology of science and the sociology of technology might benefit each other.” Social Studies of Science 14:399-441 (1984).

Restivo, Sal, van Bendegem, Jean Paul, and Fischer, Roland (ed.). Math Worlds : Philosophical and Social Studies of Mathematics and Mathematics Education. Albany : State University of New York Press, 1993.

Rose, T. Black Noise. Hanover: Wesleyan University Press 1994.

Sandoval, Chela and Davis, Angela Y. Methodology of the Oppressed. Minneapolis: University of Minnesota Press, 2000.

Schuler, Douglas. New Community Networks: wired for change. New York: Addison-Wesley 1996.

Sclove, Richard. Democracy and technology. New York : Guilford Press, 1995.

Smith, Merritt Roe, and Clancey, Gregory. Major problems in the history of American technology : documents and essays. Boston: Houghton Mifflin, 1998.

Tenner, Edward. Why things bite back : technology and the revenge of unintended consequences. New York : Knopf, 1996.

Terry, Jennifer and Calvert, Melodie (ed). Processed lives : gender and technology in everyday life. New York: Routledge, 1997.

Toumey, Christopher. Conjuring Science. New Brunswick, NJ: Rutgers University Press 1996.

Turner, Terrence. "Defiant images: The Kayapo appropriation of video." Anthropology Today 8(6): 5-16, 1992.

Westrum, Ron. Technologies & society : the shaping of people and things. Belmont, Calif.:
Wadsworth Pub. Co., 1991.

Winner, Langdon (1986) *The Whale and the Reactor: A Search for Limits in an Age of High Technology* Chicago: Chicago University Press.

End Notes

[1] Technoscience is a term introduced by Latour and Woolgar in their seminal text "Laboratory Life," in part because repeating the phrase "science and technology" became tiresome, but with an eye towards critique of the claim for clean separation between the two categories (cf. Oudshoorn's identification of this blurred boundary in chemistry and engineering). We considered naming this book "Appropriating Technoscience," but no one outside of STS seemed to know what we were talking about, so instead we are leaning on the crutch of this fuzzy boundary.

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[2] As Haraway (1991, pp. 189-190) notes, the rejection of visualization in cultural critique is based on a faulty assumption that it must always produce a god's-eye view; but any close examination reveals that "there are only highly specific visual possibilities, each with a wonderfully detailed, active, partial way of organizing worlds."

[3] Flexibility was originally introduced into STS terminology in reference to the interpretative flexibility of scientific theories (Collins), and was imported into social studies of technology by Pinch & Bijker (1984).

[4] Thanks to Rayvon Fouché for the photography example.

[5] As Appadurai (1986, p. 41) puts it, "The production knowledge that is read into a commodity is quite different from the consumption knowledge that is read from the commodity. Of course, these two readings will diverge proportionately as the social, temporal, and spatial difference between producers and consumers increases."

[6] Foucault (1979, pp. 139-141) describes such "micro-physics of power" in terms of the intentional control of minutia by those in authority, but here we see a similar force of minutia without anyone in charge.