Undone Science and Social Movements: A Review and Typology

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This is the final prepublication version. Hess, David J. "Undone Science, Industrial Innovation, and Social Movements." In Matthias Gross and Linsey McGoey (ed.), *The Routledge International Handbook of Ignorance Studies*. Routledge. Pp. 141-154.

As modern societies have become increasingly technological, science has become both more important and more politicized. Funding shifts into new research fields and out of old ones, and the changes in priorities among research fields also reorder the contours of what is known and unknown. The humanities, institutional approaches in economics, and natural science research fields that are not directly linked to industrial applications face declining prospects, whereas the support for emergent new research fields linked to industrial innovation (e.g., biotechnology, information technology, nanotechnology) raises questions about how little is known about their environmental, health, safety, and societal implications. Thus, ignorance in this historical sense is socially produced through underlying changes in the political economy of the scientific field.

Although the dominant actors in the political and economic fields exert a strong effect on the funding flows that affect the priorities of research agendas, there is a countervailing trend of epistemic modernization, that is, the opening of the scientific field to the knowledge needs of extrafield agents in less privileged and dominant positions (Hess 2007). One vector of epistemic modernization is the globalization of science and the diversification of workforces, which have altered the social composition of research fields and opened them up to new perspectives. Feminist, multicultural science studies has documented the important role of historically excluded groups who, once allowed into the scientific field and granted the training necessary to practice as peers, often bring perspectives conditioned by the habitus of their general social position. These changes are often generative for research fields, because they challenge underlying assumptions, develop new methods, and, to use Harding's phrase, strengthen rather than weaken the objectivity of scientific research by pointing to previously unrecognized biases (Harding 1998, Hess 1995).

Another vector of epistemic modernization is the more direct interaction of scientists with their publics. Scientists sometimes join social movements or provide research support for movements that have identified environmental, health, and other risks but have not been able to convince policymakers to respond with better regulation (Hess 2011b, Kinchy 2012, Moore 2008). In some cases, scientists also

engage citizens and communities to develop partnerships that lead to new research questions and new methods (Brown 2007). The result can be new research fields, such as environmental toxicology (Frickel 2004), that respond to the new problems that scientists and their publics have identified. The opening up of the scientific field to the perspectives of social movements and communities also has implications for technology policy, which has undergone its own transitions to include, albeit often in highly controlled ways, greater levels of public engagement in the policy process through various mechanisms of public consultation.

Thus, a paradox emerges in the relations between the scientific and other social fields. Scientific knowledge becomes more politicized, more caught in the cross-fire of social conflicts, but as a result of the politicization, new research programs and even new research fields emerge, and scientific research can, at least in some cases, become more strongly objective in Harding's sense. One reason is that the politicization of the scientific field also makes possible the identification of and amelioration of the problem of undone science.

Undone Science

The epistemic modernization of the scientific field, as a countervailing process to its industrialization and neoliberalization, involves the identification of a specific type of ignorance. The term "undone science" refers to a situation of unequal power that involves a conflict between reformers, such as social movement leaders, and industrial and political elites, and that is associated with absent knowledge. It is based on a situation in which reformers look to "science" for answers to questions but find a lack of research, whereas their better funded adversaries often have much more research available to support their claims (Hess 2007: 22). Thus, the concept of undone science does not refer to all research that is recognized as not having been completed, nor does it refer simply to the idea of a research agenda of identifiable but incomplete research. Rather, the idea of undone science draws attention to a kind of non-knowledge that is systematically produced through the unequal distribution of power in society, where reformers who advocate for a broad public interest find that the research that would support their views, or at least illuminate the epistemic claims that they wish to evaluate, is simply not there.

Situated within the broad interdisciplinary study of ignorance, undone science can be categorized as a known unknown rather than an unknown unknown. The potential for nescience, what Gross defines as knowledge that we only know later in the form of a surprise, is also possible (Gross 2009, Hoffmann-Riem and Wynne 2002), but mostly what scientists and their publics seek in the

identification of undone science is a kind of knowable unknown that they see as positive or desirable to study. For example, undone science takes the form of the following lament: if we only had more research on X, then we would be in a better position to known how much risk is involved in a laissez-faire approach to the regulation of X. Of course, the view of undone science as positive non-knowledge in the sense of illuminating policies that could generate a potentially broad public benefit is often contested, because industrial elites that shape the contours of research agendas through their funding preferences may not be as eager to have more evaluation of X, and they may view additional research that addresses undone science as negative non-knowledge. In other words, the distinction between positive and negative non-knowledge is perspectival. Large industrial corporations and large governmental units such as the military often have a strong influence on the political opportunity structure of research funding, either directly through their own funding processes or indirectly through influence on broader government research policy. Whereas social movements and public interest organizations may view an area of future research as positive non-knowledge, the firms and other organizations that face potential regulation may view it as negative non-knowledge.

A corollary of the concept of undone science is that it involves the systematic underfunding of a specific research agenda, and the underfunding occurs through a continuum of mechanisms. At one end, there is a well-documented literature on the active suppression of scientists who produce evidence that demonstrates risk and dangers associated with new technologies or technologies for which there is a broad public dispute (Delborne 2008; Martin 1996, 2007). At the other end, there is the more subtle process by which a government response to undone science leads to the selection of problems that create new pockets of undone science even as the first-order undone science is addressed. For example, the U.S. government created the Office of Alternative Medicine and later the National Center for Complementary and Alternative Medicine within the National Institutes of Health in response to claims of undone science from patient advocacy leaders, clinicians, nutritional and mind-body researchers, and allies in Congress who argued for public funding of the evaluation of complementary-and-alternative medicine (CAM) approaches to the treatment of cancer. However, the research funded through these organizations tended to emphasize complementary over alternative modalities, prevention over treatment, and other chronic diseases over cancer. Thus, a response to first-order undone science created second-order undone science. As I have shown (Hess 2015), it is possible to map these gradations of second-order undone science with a degree of quantitative precision; nevertheless, although quantitative analysis is possible, the ability to see what kinds of studies are unfunded requires a fairly deep ethnographic knowledge of the history and political context.

Research on undone science has revealed several areas of complexity that have moved the analysis beyond the first-level binary of movements versus industrial and political elites. First, the articulation of a known unknown does not always mean that it is technically possible to get the undone science done. As Howard points out in our extended discussion of undone science, some knowledge, such as the interaction of a suite of chemicals with complex biological processes, may be undone but also undoable (Frickel et al. 2010). Of course, the barrier of "undoable" science may be partly technical and financial, and consequently it is potentially surmountable over the long run. Recognition of not only undone but undoable science has policy implications for the deployment of precautionary rationales in the regulatory field, because it transforms a precautionary policy from a temporary status (a moratorium until more research is done) into a permanent status. Second, as Kempner has noted, social movements can also play a role in creating undone science, because they may argue for the broad social benefits associated with not pursuing a line of research (Frickel et al. 2010, Kempner et al. 2005). In addition to the example of animal rights research, there is also work on the role of scientists in attempting to halt various types of weapons research (Gusterson 1996, 2004; Moore 2008; Oreskes and Conway 2011). Third, social movements and reformers themselves are often divided, and consequently there may be different articulations of undone science (Gibbon in Frickel et al. 2010). Large civil society organizations have the financial capacity to fund some kinds of scientific research, thus generating "civil society research" as one mechanism of getting undone science done, but the research of large civil society organizations tends to be more moderate politically than the kind advocated by the less well-funded, often more radical organizations in a social movement field (Hess 2009b). Insider organizations may also lobby governments to get funding released—such as occurred for the increase in funding for environmental, health, and safety research for nanotechnology (Hess 2010)—but the more radical social movement organizations in the field, which in this case advocated for a broad moratorium, view such research as limited and coopted.

Another area of complexity in the study of undone science is the relationship between social movements and scientists. Activists and advocates are sometimes able to recruit scientists to work with them, either by providing them with funding or by gaining their support on a pro-bono basis. In the environmental health field, this work often involves challenges to what Brown (2007) calls the "dominant epidemiological paradigm." The relationships can involve quid-pro-quo negotiations between scientists and reformers (Clarke 2008), and they can also create tensions and ambiguities, because scientists do not often produce the results that reformers want to see (Yearley 1992). Scientists also make choices about the strategies they use to draw attention to the need for new research. As Allen

(2003, 2004) has shown, they may adopt a highly public and media-oriented strategy that produces the political will for more research, or they may shun the public limelight and try to produce robust, peer-reviewed knowledge.

When forming alliances with social movements and community groups, scientists sometimes step out of their role as actors within a research field, in which there is generally a struggle among networks of researchers to define the dominant research programs, to a more public role in which they address the broad policy issue of a blockage of one area of research that is of potentially broad public benefit. When scientists "go public" with their criticisms of research funding priorities and the public benefits of changes in those priorities, they form an alternative scientific counterpublic that contests the linkage that official publics draw between broad public benefit and the status quo of research funding patterns (Hess 2011b). In some cases, scientists also form alliances with social movements and alternative industrial groups to develop political support for alternative research agendas. These scientific counterpublics are often linked to the more traditional counterpublics associated with advocacy groups and social movements connected to persons in subordinate positions in the social structure—by race, ethnicity, class, gender, sexuality, etc.—and to the sciences from below that emerge from those differences in perspective (Fraser 1997; Harding 1998, 2008). However, the scientific counterpublics need not have that connection; they can be composed of relatively privileged persons, such as credentialed research scientists and well-educated leaders of social movement and professional reform organizations. Thus, the scientific counterpublics are distinguished by their subordinate positions in the political field, and sometimes also in the scientific field, rather than their subordinate position in the broader social structure.

A Typology of Undone Science, Industrial Change, and Social Movements

The concept of undone science is best understood when embedded in a theory of scientific field dynamics and industrial change. Theory in the social sciences can be based on models in the tradition of economics, where the theory relates agents such as advocacy organizations and firms to each other via a set of decision rules and optimization dynamics, but it can also be based on the Weberian tradition of the construction of ideal types that involve sequences and processes in the interactions among types of agents. The ideal types are intended less as the basis for formal models that can be tested and more as the basis for empirical research on specific historical and ethnographic cases that are often an amalgam of types. This latter, Weberian concept of theory is utilized here, and within that broad approach to theory this analysis draws on the theory of social fields.

Table 1: A Typology of Undone Science, Industrial Innovation, and Social Movements

	High Epistemic Conflict: Scientific Counterpublics	Low Epistemic Conflict
Technology/Technique Targeted for Sunrise	Alternative industrial movements (undone science as research on alternative technologies, products, and production techniques)	Industrial restructuring movements (undone science as research into the new organizational forms)
Routinization Phase	• Funding granted for research but often limited • Countervailing industrial power • Complementarization through incorporation & transformation • OR industrial regime transition through transformation and/or certification schemes	• Diffusion of new organizational forms • Radical restructuring of industrial organization in an industry • OR organizational forms remain in niche position, and large firms coopt some aspects of organizational innovation.
Technology/Technique Targeted for Sunset	Industrial opposition movements (undone science as research on research on risk, safety, uncertainty)	Industrial access movements (undone science as support for research on access issues)
Routinization Phase	• Funding granted for risk evaluation and partial moratorium with precautionary politics • Governments respond with public participation mechanisms and softening of technocratic governance • Industry may block change with contrarian science strategies	• Funding granted for access research • Advocacy organizations partner with industry to develop research agendas • Advocacy organizations shift into service provisioning • Contrapublic dynamics emerge more from neoliberal ideology

Table 1 provides a typology of undone science with respect to the relationship between social movements and industrial-technological change. The term “social movement” is used here as an umbrella concept that includes both extra-institutional action (e.g., disruptive protest) and institutionalized action (reform) that includes technological and market innovation as well as policy change. Social movements are understood as broad mobilizations of persons and/or organizations that oppose the dominant patterns of society and politics, whereas interest groups are configurations of persons and organizations that attempt to garner more resources for a social segment or sector. There are gradations between the two categories, and the access movements can be very close to traditional interest groups.

The typology is based on case studies developed mainly in the STS literature, and the discussion that follows is a modified and more elaborate version of the one originally developed in Hess (2007). The first organizing axis is the level of epistemic conflict engendered by the identification of undone science. Although epistemic conflict is endemic to all scientific research fields, this typology assumes that a distinction can be drawn between relatively higher and lower levels of epistemic conflict in a research field and its extrafield relations. The second organizing axis is the relationship to industrial and technical change, that is, reforms that support the creation of alternative technologies, techniques (practices), and/or organizational structures (sunrising) or those opposed to existing or emergent ones (sunsetting). Again, the level of conflict is variable, based on the degree of opposition to an existing industrial order. These typological categories can be thought of as representing a continuum when applied to concrete cases.

In the first type (upper left quadrant), alternative industrial movements (AIMs) focus on the sunrising of new technologies. There are two basic types of AIMs, technology- and product-oriented movements (TPMs) and certification movements, and the latter may develop out of the former. Thus, consistent with the literature on social movements, the issue of phases is very important (e.g., Soule and King 2006). Both types of AIMs may be anchored in formal nonprofit organizations and informal movement networks, but the TPMs are also frequently located in small, entrepreneurial business enterprises that occupy a potentially disruptive niche in a broader industry. Examples include, during the early phases, the movements for sustainable and local food, rooftop solar, alternative medicine, recycling and reuse, open-source software, community media, and alternative-fuel vehicles. What may begin as a TPM (e.g., off-grid rooftop solar in a home power movement) may later become the basis of certification campaigns directed at the state and/or corporations that have the aim of shifting the existing industrial regime to adopt standards that are compatible with the new product (e.g., solar carve-outs of renewable portfolio standards). However, the certification campaigns may be developed by a different set of organizations, such as environmental organizations, in contrast with the networks of inventors and entrepreneurs that characterize the TPMs. Often large industrial organizations ignore both the TPMs, which are seen as fringe niches, and the certification efforts, but later they may adopt modifications in their production technologies and products in response to perceived market opportunities from the TPMs and market pressures from the certification movements. In turn, the large organizations may even adopt certification schemes. However, it is also widely recognized that when large firms adopt certification schemes, they tend to attempt to dilute them through various mechanisms, such as by creating industry-controlled certification labels (Jaffee 2012).

Within AIMs the TPMs frequently draw attention to the problem of undone science (Hess 2005, 2011). Scientists who support the development of new technologies in these industrial fields may do so quietly, such as by devoting a portion of their research portfolio to pro-bono works in this area, or they may decide to leave the research field to become entrerpreneurs or advocates. But they may also join with the networks of advocates and entrepreneurs as scientist-researchers to form an alternative scientific counterpublic that advocates for higher levels of research funding in support of the new technologies. When they do so, they raise the level of epistemic controversy by politicizing the funding agendas for a research field. Examples include the movements and associated scientists that draw attention to the relative imbalances of public funding in areas such as food and agriculture toward small, sustainable forms of agriculture or in medicine toward nutritional therapeutics for cancer (Hess 2007). The challenger knowledges can include networks of local and alternative professional knowledge (farmers, CAM practitioners) that are linked to credentialed researchers who occupy subordinate positions in their research fields (e.g., organic agriculture researchers in schools of agriculture and alternative medicine researchers in schools of nutrition or naturopathy). Conflicts can become intense scientific controversies, as in the case of the claim that enzyme-based nutritional therapies can be effective in the treatment of pancreatic cancer (Gonzalez 2012, Hess 2015).

If the TPMs were to scale up successfully from industrial niches to new industrial regimes, and/or if the certification movements were to enforce a significant change in industrial production processes and products, they would bring about disruptive transformation of an existing industry. One might think of this outcome, in the terminology of innovation studies, as an industrial transformation in which the fundamental basis of the sociotechnical regime changes (Geels and Schot 2007), and in the terminology of institutional analysis, as a new settlement after a period of deinstitutionalization (Rao and Kenny 2008). However, the tendency is for the movements to undergo an incorporation and transformation process that results in much more modest forms of technological and industrial change. For example, the challenger technology embedded in entrepreneurial firms can be acquired by large corporations (e.g., by buying up small solar or organic food companies), or the corporations can set up their own divisions to colonize the niche (e.g., organic food divisions in large food companies). In the process, the alternative technologies are often redesigned to make them more compatible with the existing industrial regime (the “complementarization” process). For example, large food processing companies now offer frozen and packaged variants of organic food, and off-grid solar energy has been transformed from local to non-local ownership as a result of the shift to financing based on power-purchase agreements (Hess 2005, 2013). Often a countervailing industry plays a significant role in the

transformation process by providing financing to the alternative research programs and to the scale shift (escape from industrial niche status) of the new technologies and products, such as the nutraceutical industry for the alternative medicine field and the finance and technology industries for the solar energy field (Hess 2013, 2014).

The second type of relationship among undone science, industrial change, and social movements, industrial restructuring movements, also involves a "sunrise" dynamic, but it is less focused on material technologies and products and more on the ownership dimensions of industrial organization (what one might think of, in the science and technology studies context, as organizational technologies or techniques). Historically, social movements representative of this type of industrial change called for government ownership of the major means of production, and these movements can still be found, especially in less developed countries where there can be intense struggles over privatization and public ownership, such as for water in Bolivia and petroleum in Mexico. At the other extreme, in the U.S. today, there are few socialists who occupy positions of power (e.g., Senator Bernie Sanders of Vermont), and movements to support increased public ownership are not influential at the state or federal government levels, with a few exceptions at the local level, such as mobilizations to support the municipalization of electricity in some cities and to protect public ownership of drinking water. In general, in developed countries other kinds of restructuring movements are more prominent, such as reform movements that attempt to shift policies and consumer loyalties toward locally owned, independent businesses (Hess 2009a). There are also movements in support of alternative forms of economic ownership, such as cooperatives, B corporations, social enterprise, and employee ownership (Williamson et al. 2002). In some cases, such as municipal electricity utilities and various cooperatives, the organizational forms are legacy outcomes of previous eras of social movement mobilization that have undergone subsequent reinvigoration, such as cooperative and small-business movements that became invigorated in the wake of the 1960s social movements (Hess 2009a, Schneiberg et al. 2008). Certification movements can also support alternative industrial forms, such as agrarian cooperatives and modified labor regimes found in fair trade and supply-chain certification schemes.

Industrial restructuring movements are similar to the alternative industrial movements in the sense that they also attempt to create alternatives to the existing industrial order, and in this sense both are about sunrising new industrial forms. However, the level of epistemic conflict is generally lower than for the AIMs, because the relevant research fields are in the social sciences that study the alternative organizational forms. These research fields tend to appear in the lower-status social science disciplines such as sociology and in the humanistic social studies fields such as cultural anthropology and history.

Within these relatively marginalized fields, researchers who study alternative economic organizations are not necessarily marginalized, but those who adopt explicitly socialist perspectives may be or at least may be located outside the elite universities (e.g., Foster et al. 2010). Again, the marginalized position of related research programs can be studied with quantitative precision, including reflexively for the position of certain types of research agendas in the STS field (Hess 2011a). Conversely, the elite networks of the social sciences that connect the business schools with the departments of economics tend to shun such work as "normative," "political," or "not rigorous." Thus, the research is not necessarily intensely controversial within its reference research field, but studies of the topic are also undone science within the dominant networks of the dominant social science disciplines.

The routinization phase for these movements can involve industrial transformation, such as would occur with the nationalization of an industry or the municipalization of an electricity or water system. However, the more common form of routinization is the widespread diffusion of the new organizational models and the incorporation and transformation of those models into the large industrial corporations. Thus, in the U.S. today there is a proliferation of local first movements, bank local and local currency movements, cooperatives, credit unions, B corporations, worker ownership, and, to a lesser degree, the municipalization or remunicipalization of services, but these innovations tend to remain in a niche position with respect to the model of the publicly traded, large corporation. Instead, large corporations have selectively adopted some of the elements of the movements while simultaneously rejecting the fundamental challenge that they had aimed to propose. Thus, large corporations have incorporated fair trade and local products in their retail offerings, and "buy local" movements encounter the use of local loss leaders in the large chains (a few locally made products strategically positioned at the entrance to stores) or even the creation of stealth independent coffee shops owned by large chains. Likewise, cities such as San Francisco may turn to community choice aggregation when their efforts at municipalization are rebuffed by the investor-owned utility (Hess 2009a).

The third type of movement and undone science involves industrial opposition movements, which advocate the sunsetting of specific technologies and products (e.g., especially toxic chemicals) or even of whole industries (e.g., nuclear power). This is the more well-traversed terrain of social movement studies with respect to industry (e.g., King and Soule 2007, Weber 2009). Examples include mobilizations against genetically modified food, specific chemicals or classes of chemicals (e.g., chlorinated chemicals) that pose environmental and/or health threats, electromagnetic radiation risk (both ionizing and non-ionizing), and nuclear and fossil-fuel energy. Epistemic conflicts emerge

between social movements and the government and/or industry over the level of risk associated with existing or emerging technologies, products, and production techniques; the potential unknowns and the credibility of existing research on risks; and the degree to which there is undone science on risks and potential harm. As in the AIM type, there is a high level of epistemic conflict, because scientists who produce studies that document risk for the technologies of established industrial regimes often find that their work is attacked or at least rebutted by industry-funded scientists. Epistemic conflict can also increase when communities affected by toxic exposure develop their own methodologies to document their exposure, as in the case of "lay epidemiology" and "bucket brigades" (e.g., Brown and Mikkelson 1990, Kroll-Smith and Floyd 2000, Ottinger 2013).

In addition to conflict over the credibility of research that documents risks and other potential problems of industrial technologies and products, there is broader epistemic conflict over how to translate knowledge or the lack of knowledge into policy. Strategies range from hyper-precautionism, which urges a temporary or partial moratorium until more knowledge is available, to free-market liberalism, which urges release of products onto markets because they have not been proven to be unsafe. When governments do not accept demands from movements for a precautionary approach, street protests in favor of a moratorium may occur, and they may exert a radical flank effect that opens the political opportunity structure for moderate reformers who call for greater funding for risk assessment (as occurred for genetically modified foods in Europe, with spillover effects to nanotechnology). In most cases we find a modest regulatory response, such as the labeling of genetically modified food or a moratorium on a small number of nanomaterials. Industry may also redesign some products in order to mitigate public concerns but also to keep the products on the market (e.g., removing the most allergenic genes from GM food). Where there is an absence of a social movement mobilization, regulatory policy will tend to follow the directions established by industry, even if civil society organizations have institutionalized access to the policy process, as we have shown in the case of nanotechnology policy in Europe (Lamprou and Hess 2014).

In some cases, industry shifts its strategy from merely criticizing research that suggests risk and safety issues to full-blown disinformation campaigns by industry-funded researchers. The paradigmatic cases are smoking and climate research in the U.S., but Oreskes and Conway (2011) discuss other cases. Analogous to the alternative scientific counterpublic discussed above, we can think of these networks of researchers as a scientific contrapublic. Contrapublic scientists have general scientific capital but generally lack standing within the relevant research field, such as the climate contrarian scientists who do not have standing in the field of climate science but who may be otherwise respected in their home

fields. On this point, an editorial in the *Wall Street Journal* by climate scientist Kevin Trenberth (2012), and cosigned by 37 other climate scientists, compared skeptical statements by a group of prominent scientists to consulting a dentist for a condition that requires heart surgery. Credentialed in their own fields but not in the relevant field, the contrapublic scientists develop a claim that there is undone science, when in fact there is a relatively high level of consensus among credentialed experts in the research field. Although science is never done, there is enough consensus within the research field to make policy recommendations, such as the need to eliminate airborne emissions that cause acid rain, ozone depletion, and global warming.

Although in the case of climate science there is low epistemic conflict within the relevant research community, the contrapublic makes epistemic claims in the political field (e.g., climate science denialism) that in turn lead to the corralling or sequestering of the legitimately credentialed scientists from their role in the policy process. Thus, rather than playing a neutral role in the political field, in which scientists inform policymakers of problems that need to be addressed and therefore create the doxa upon which diverse policy responses can be debated, their knowledge itself becomes framed in a politically polarized field as associated with one side of a policy dispute. An epistemic rift occurs in which the traditional advisory relationship between a research field and policymakers breaks down, because the polarized policy field utilizes the contrarian science to make the claim that the scientific research is equally divided by ideological currents. In this situation, the mainstream of scientific researchers acts as a countervailing counterpublic in policy debates that are dominated by industry-oriented official publics and their contrapublic scientist allies (for more on these relationships, see Hess 2014).

Social movements that wish to develop a stronger political opportunity structure for precautionary policy may also draw attention to scientistic or technocratic aspects of the decision-making process (Kinchy et al. 2008). In response, governance processes can undergo epistemic modernization, at least in a limited form, by integrating mechanisms of public engagement such as open-commentary periods, lay consultations, focus groups, and consensus conferences. One result of increased public engagement can be the identification of undone science in the form of risk assessment; however, a fully democratic process could generate a situation in which risk assessment shows that a new technology is not very risky, but the public could reject it on other grounds, such as simply wanting to preserve the sociotechnical system dynamics of an existing regime. An example is the rise of grassroots opposition to smart meters. Although scientific risk assessment on the health concerns of household level microwave radiation has not reached a consensus, if the consensus were to emerge in favor of the claim that there is minimal or no health risk, public rejection of the technology could be on

other grounds, such as desiring analog systems that are less amenable to terrorist attacks and privacy invasion (Hess and Coley 2013). Winner (1986) has likened this approach to refusing to hit the "tar baby" of technocratic decision-making by instead asking questions about the general social desirability or lack of desirability of new technologies and products.

Because of this risk to industrial elites and sympathetic policymakers that is embedded in a fully democratic process of public engagement, the mechanisms of public deliberation are often tightly controlled so that they end up with outcomes that are consistent with decisions that have already been made (Wynne 2005). One form of control is to restrict the definition of the "public" to the individual layperson who is relatively ignorant of the regulatory issues at stake, and although the lay public can be transformed into an opinion-generating public, these mechanisms of participation tend to exclude social movement organizations along with industrial firms and associations on the assumption that all are interested "stakeholders" (Hess 2011b). The result is the construction of participatory mechanisms that enables a continuation of scientistic politics but with the legitimating mantle of public consultation that also displaces the capacity of movements to claim legitimacy as representatives of broad public interest. Furthermore, often a condition of participation is a restriction of the terms of debate to issues of safety and risk. When participatory processes include public-interest and social movement organizations, a dilemma emerges for those organizations: either refuse to become involved in technical decision-making by remaining on the outside of the political process, or hit the "tar baby" of restricted risk frames and attempt to gain incremental changes in policy outcomes that lead to more research and some regulation (Kleinman and Kinchy 2007, Kinchy 2012). These strategic decisions produce divisions among civil society and social movement organizations that can then weaken their capacity to mobilize broadly and effectively.

The final category involves movements that advocate the end or sunsetting of specific kinds of inferior products, such as substandard housing, transportation, health care, and inferior food options for low-income communities. Access movements can include conventional poor people's movements that advocate for affordable access to basic material goods such as shelter, transportation, quality health care, and food. However, class, race, and traditional social inequalities are not the only source of mobilization. In the health field, these movements can include groups that mobilize against the existing lack of therapeutic choice for identified diseases, such as advocacy work by patient organizations that view their diseases as under-represented in public funding portfolios (Epstein 1996, Klawiter 2008). Diseases may be relatively rare and therefore orphaned, not rare but at one point relatively underfunded (e.g., AIDS and breast cancer before the patient advocacy movements), or not rare but

with little incentive from the private sector to invest due to poor profitability (e.g., diseases prominent in low-income countries). Access movements thus span the range from disruptive anti-poverty movements to organizations that operate as interest groups in the sense of seeking greater resources from the government and from corporations for research about a specific disease.

In the politics of access, there is low epistemic conflict because the goal is gaining access to a higher quantity and/or quality of conventional technologies and products rather than challenging the dominant knowledges and technological designs. In contrast, in the AIMs such as the movement for complementary and alternative cancer therapies, the goal is to redefine the horizon of therapeutic choices by challenging dominant epistemic assumptions. The difference in perspective is crystallized by a comment once made to me by a CAM advocate about the AIDS movement, who said that AIDS patients were a model of "success," but they should be careful what they ask for when they say they want "drugs into bodies" (i.e., drugs that at the time had low efficacy and high side effects). Likewise, when talking about green affordable housing with a low-income housing advocate, the reply I once received from an affordable housing advocate was that he would love to have green housing, too, but he did not want to ask for too much. So this typological distinction aims at capturing these practical cognitive categories that divide the field of advocacy and activism (see also Brown et al. 2004, who make a similar distinction in their discussion of health social movements).

Because the access movements, as a type, do not challenge the dominant epistemic paradigms and technological regimes, they are easy to incorporate into existing industrial regimes. Once funding is available to support the access (from financial institutions as loans or from the nonprofit or public sectors as grants or aid), it is merely a question of increasing the quantity of goods provided. A confluence of interests emerges among the movement organizations, the funding sources, and the supplying firms. To the extent that a contrapublic is identifiable in this field, it is the general contrapublic of neoliberal ideologues who reject non-market approaches to solving problems of societal inequality. They frame access movements as asking for hand-outs and transfers from the hard-working citizens to their lazy counterparts, and successful disease advocacy organizations may also be portrayed as having gained a level of research and therapeutic support that is not calibrated to the disease population (e.g., an oversupply of funding to AIDS and breast cancer research). Political compromises that emerge from such disputes tend to use market mechanisms, public-private partnerships, governmental devolution, and other strategies to accomplish access goals while also moderating neoliberal framing.

In response to the growth of access funding and its privatized forms, movement organizations that may have once mobilized to demand access may find new opportunities as service provisioning

organizations that have new revenue streams and organizational missions based on funds flowing from their government, nonprofit, and corporate sponsors. Corporate sponsors may even provide the organizations with training to lobby governments for more funding, including research funding to support the expansion of access. For example, in the case of breast cancer organizations, there has been a strong trend toward increased funding to the organizations that support conventional drug research (and marginalization of the original, more epistemically "radical" organizations that had connections to the TPM of CAM cancer therapies), and patient advocates in the larger and more well-funded organizations engage in lobbying for changes in the allocation of research funding that is consistent with the industry's goals of developing new, patentable, and profitable products (Batt 2014, O'Donovan and Glavanis-Granthan 2005).

Conclusion

In summary, the problem of undone science is approached from a political sociological perspective that includes the extrafield relations with governments, industries, and social movements and civil society (Moore et al. 2011, Frickel and Hess 2014). Although the conflict between the more and less powerful is fundamental for understanding undone science, it is also necessary to move beyond a simple "vertical" model of conflicts between disempowered movements and elites; hence, the analysis shifts into a typology of relationships among science, the state, industry, and civil society.

A typological approach to the analysis of movements, industrial change, and undone science can provide a valuable framework for research on the complex dynamics of the interfield relations and the politics of scientific knowledge and non-knowledge. Although some dimensions of the types could be formulated as testable hypotheses amenable to quantitative analysis, it is likely that the primary benefit is more in the Weberian tradition of providing a source of sensitizing categories and sequences for historical and ethnographic case studies and their comparative analysis. Furthermore, there is also a second-order benefit from the project of constructing the ideal types and their sequences in the manner suggested here: it suggests the value of bringing together the fields of science and technology studies, social movement studies, industrial innovation studies, and institutional analysis.

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