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DEEPENING THE FIELD, RAISING THE STAKES

Generating Technologies for Inclusive and Sustainable Development

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Members of the Sociology of Technology and Innovation Area of the Institute of Science and Technology Studies of the National University of Quilmes (the Quilmes team), Buenos Aires, remember 2009 as a turning point. In that year, a group of researchers began to transform their research praxis. The transformation included a series of analysis objects and questions, new ways of engaging nonacademic actors, and explicit political positioning regarding a positive intervention in the dynamics of inclusive and sustainable development.

Little over a year earlier, the Ministry of Science, Technology, and Productive Innovation (the S&T Ministry) had been founded with the goal of "deepening a productive and social development model based on generating value through knowledge."[1] The government's promise to invest in science and technology to create greater social and economic well-being confronted a lack of specific public policies and tailor-made management instruments. What could it mean to deepen a productive and social development model? In particular, what science and technology (S&T) policies could possibly generate inclusive development processes in a country that had undergone thirty years of destruction in its productive matrix, a systemic downgrading of innovation, and significant increases in unemployment and structural poverty? Would it be possible to develop technological solutions for what were widely considered to be the chief social issues in Argentina—for example, lack of access to drinking water, housing, and energy; high costs of medication; and prevalence of regional diseases that still had no cure? These were some of the issues that officials wanted to solve, leading them to invite us to take part in the public policy design process for the new ministry.

We were convened as advisors to help design public policy instruments for science, technology, and innovation (STI) that could generate technological solutions to social issues. The invitation appeared to us to be two faces of the same coin. It

was a remarkable opportunity to influence the design of public policies. At the same time, it posed a clear challenge to our knowledge, ways of learning, and practices as STS researchers.

We saw in the opportunity the possibility of generating policy instruments for STI that might, by design, avoid some problematic features of the praxis of knowledge generation in Latin America. Three of those features can be summarized as follows:

1. The generation of knowledge in Latin America (Argentina in particular) takes place within an agenda of topics and issues generated exogenously. S&T agendas in the region have barely focused on the needs of the local population. A vast literature describes the relative neglect of social agendas by leading R&D institutions (e.g., Albornoz 1990, 1997; Bisang et al. 1995; Dagnino, Thomas, and Amilcar 1996; Kreimer 1996; Oteiza 1992; Thomas and Dagnino 1999; Vaccarezza 1990; Vessuri, Díaz, and Teixeira 1984).
2. Problem-solution dynamics usually aim at realizing profits through relative market monopolies (Rosenberg 1982; Schumpeter 1928). Innovation is reduced to generating new merchandise rather than satisfying social and environmental needs (Becerra and Thomas 2017).
3. The praxis of technological development continues to be ruled by the linear innovation model, leading to a supply-side focus both in establishing the agenda of issues and in generating solutions (Thomas 1999, 2007, 2008a).

As a coconstructed process, these opportunities reflected challenges we faced yet presented them in a different ontological order. Could we be researchers looking for critical analysis and informed academic discourse, but also working with other social groups (e.g., policy makers, practitioners, social movements, and civil society entities) in order to produce solutions for social and environmental problems? The question "How is a local agenda of issues constructed?" is not just a question about how others work. It also concerns how we make a local agenda. At the same time and in the same way, could examining the legitimation of a policy process in terms of different relevant social actors (academic community, sources of financing, decision makers, and so on) be related to preserving our own political, theoretical, and ideological positions?

If it is possible and, indeed, necessary to operate with non-Schumpeterian rationales of development and technological change in order to make social development processes more dynamic, how can that be achieved? Are the theoretical concepts we have to inform public policy sufficient? Are they adequate? And again, as a twofold dynamic: Are there other researchers who failed when facing the same or a similar situation? And if they failed, why? Was it due to theoretical, political, ideological, or practical reasons? Is it possible to confront and deal with an entire system of research evaluation that doesn't, in fact, care at all about such matters?

Finally, if we accept the idea that technology is not neutral, is not deployed linearly, and does not work in the same fashion at all times and in all places, is it possible

to develop public policy actions that manage not to fail? Might it be possible to develop a dynamics for producing nonapplied applicable knowledge? That is, could we produce knowledge we could defend as applicable but not applied because its production was responding to a specific local need or demand (Kreimer and Thomas 2003, 2004; Thomas and Kreimer 2002)?

The main goal of this chapter is to share the experiences and present the lessons generated when we researchers in the STS field put ourselves through this twofold concrete action that produced in our research work a dynamic transformation. We want to stress in particular that, in a coconstruction dynamic, the problem agenda, knowledge generation, and researcher concerns and activities, and also the very notion of what a researcher is, changed. Using a reflexive methodology, we analyze a set of concurrent dynamics that produced the transformative dynamic of making & doing in the Quilmes team: a modification of the research agenda and generation of new concepts and a transformation of researcher praxis, integrating design skills in public policies and as direct, on-site implementers of those public policies.

The analysis explores the experiences of one team in designing and implementing the Right to Access to Goods: Water for Development (DAPED) project (hereafter known as the water project). The water project sought to generate actual dynamics of local development in very poor rural regions of the Argentine north, starting with access to water. It also sought to produce a laboratory for the design of new public policies and public instruments for two national ministries. This work became a partnership between the National University of Quilmes and the National Institute of Agricultural Technology (INTA), with the support of the S&T Ministry and the Ministry of Social Development. We offer this case because the researchers involved bore direct responsibility for executing the local development project and for linking the knowledge generated in the field to the design of future policies.

DEEPENING THE FIELD: FROM RESEARCH OUTPUTS TO DIRECT INTERVENTION

In an ideal situation, informing a public policy on any subject in which a research group is working would be the result of a mature research process. That is, if we assume an ideal and linear world, research comes first, new concepts based on empirical analysis are produced, and then research results are produced (papers, books, conferences), and that knowledge is transferred to the public or private sector, which needs the new developments.

However, in concrete actions, events do not (cannot) develop following that linear order. In practice, a coevolution takes place in which issues to be solved stress existing knowledge; agendas are modified as communication and negotiation mechanisms are established between researchers and policy makers; and what stakeholders understand as "desirable/undesirable, possible/impossible, and existent/inexistent" (Therborn 1987, 75) is reconfigured as actions are deployed.

In 2009, policy makers in the S&T Ministry presented the mission as an institutional deficit. The new ministry lacked an action line in its mandate for generating knowledge-based social development mechanisms. They wanted to rectify this absence. The emergent solution, presented against the backdrop of established practices for institutional policy making, was to create new programs or adapt existing funding. However, through a collective evaluation involving ministry officers and the Quilmes team, all came to understand that any actions taken would require a clear definition of the hierarchy of issues (to identify the ones that would receive public funding), the types of policy instruments to be used, the concepts for addressing the desired actors, and the criteria for assessing the results of new policies.

In our case, while the Quilmes team had research experience and academic production regarding STI in public policies (for example, about the S&T public policies deployed in Latin America during the twentieth century), we had a more traditional STS agenda geared toward historical analysis of S&T. Examples include the treatment of smallpox along the Río de la Plata during the eighteenth century, the production of slave ships in the nineteenth century, and the development of the Argentine metalworking industry in the mid-twentieth century. The new research team was led by a senior researcher with a PhD in S&T policy[2] and consisted of five PhD students working on issues related to the history of technology and two who had some fieldwork experience with appropriate technologies.[3] With this configuration, the team faced its first crossroads. If team members were to design new STI policy instruments—something we saw as desirable—what needed to happen within the team to make this happen?

Two possible roads lay ahead. The more traditional option was to provide a standard consultancy service of analyzing the client's issues and generating cognitive inputs to solve them. This was the simplest option. However, it has few feedback mechanisms and limits the team's potential capacity to codesign and follow up the policy, which limits the team's ability to learn from the experience and reorient (at least partially) the policy actions.

The second, more radical, option was to alter the whole orientation of the team's work. Transforming the research agenda in order to develop a series of studies with an empirical base and new concepts might make it possible to codesign STI public policies in more structural terms. Such a change needed two conditions: (1) the team's continuous and lasting involvement in policy processes, given that research work creates long-term results (compared with traditional consultancy); and (2) creation of inputs used in the research process to generate intermediate results that would dynamically nurture the policies.

Facing that crossroads, the strategic decision became an ideological definition (Therborn 1987) in the sense that there are no good or bad decisions from a rational point of view regarding technological, social, and economic development in society, but rather desirable or undesirable definitions based on a political positioning.

We chose the radical option. This led to two dramatic actions at once. The first was to modify the research agenda toward creating useful answers for policy making—that is, how to design, produce, manage, and assess technological development policies for solving social and environmental problems. The second was to transform the researchers' praxis in order for it to have an influence on the design of public policies and to generate institutional articulation mechanisms, with the goal of strengthening and broadening the scope of our actions.

MODIFYING THE RESEARCH AGENDA

To orient a research agenda toward the resolution of social and environmental issues is no trivial task. We had to bear in mind that the agenda should enable academic production in order to meet the evaluation requirements of the S&T institutions in which we worked. In addition, research results should inform policy design. And the team needed prior concepts and discussions (economic, academic, political, and social) to construct interactions, in some cases as partners and in others as rivals.

The team gradually integrated these three issues in dynamic terms through two continuous actions. The first involved moving from an agenda of topics to one of research problems. The second was to construct a critical analysis of approaches for technology inclusion and to devise an organizing concept to be used as a lighthouse.

CHANGING THE AXIS FROM TOPICS TO PROBLEMS

In these first years of the twenty-first century, Latin American countries have been posting positive data about economic growth. However, alarming social and economic indexes reveal underdevelopment. Huge sectors of the population (between 20% and 50%, depending on the country and the indicator) suffer from shortages of housing, food, education, and access to goods and services. Argentina is one of the more dynamic Latin American countries in social and economic terms. The country has grown almost constantly since 2003 and shows improvement in several social indicators, such as poverty and unemployment, and in access to basic services and primary education. Yet inequality persisted in income distribution and structural deficits, including decent housing, transportation, access to sanitation and energy services, and environmental problems.

Housing in 2010 in urban areas, where 70% of the population lives, had a total shortage of 660,000 units, or a deficit of 8.7% (Centro de Estudios Legales y Sociales [CELS] 2010). Moreover, although most urban households in Argentina (98.9%) had access to drinking water, only 64.2% had access to a sewage network (CEPAL 2010). Also, even though the country is one of the major food producers in the world, Argentina had a food deficit affecting 5% of the population in 2005–2007, according to data from the Food and Agriculture Organization of the United Nations (FAO 2011).

Examining these data led the Quilmes team to think about how to construct technological solutions that could be adapted to existing problems and resources. The technological complexity of housing-, water-, food-, and health-related social issues presented a window of opportunity for new types of interventions in new spaces. The conversations were long and difficult, however, because these issues differed greatly from those team members had worked on in 2008 and 2009. Still, the research agenda moved toward the priority issues of food, water, energy, health, and housing, and who might be expected to use research results.

Policy making requires more than an analysis of the energy sector, housing, or access to water and sanitation or framing questions such as "How is habitat produced in Argentina?" The design of public policies relies on research into technological development alternatives that may or may not produce inclusive dynamics or exclusionary processes. Thus, the archetypal question becomes: How and for whom does the development of artifacts, processes, or technological systems work or fail to work in addressing and solving a given problem?

Consequently, in concrete terms, the change of agenda meant that team members would have to formulate new research projects, applying for financing that rewarded research and the generation of public policies. The institute would have to reconfigure the master and doctoral theses of researchers in training. The team would have to integrate new types of members.[4] Team members would have to reconfigure their strategies for scientific publication. And the team would have to develop an institutional communication strategy aimed at challenging political and social agents.

During this first phase, one of the most important initiatives was creating the Network of Technologies for Social Inclusion (RedTISA). RedTISA brought together a collaborative network of public and private institutions aimed at strengthening and improving the capabilities of innovation and technological development for social inclusion. It was coordinated by the director of the research team (Hernán) and one of the research fellows (Paula) together with an official from the S&T Ministry and representatives from social organizations. The ministry official led the Program-Council of the Demand of Social Actors, founded in 2008, which approached the Quilmes team to design a call for proposals for projects aimed at solving social issues.

The main idea behind RedTISA was to fill an enormous gap in institutional coordination.[5] It assigned itself the responsibility to organize, coordinate, and integrate a diverse collection of public and private institutions and organizations (universities, nongovernmental organizations, labor cooperatives, research and development centers, among others) that wanted to contribute to the country's social inclusion and sustainable development. In this sense, it provided a collaborative platform for leveraging at a national level actions, insights, and recommendations generated by the Quilmes team and other members of the network.

GENERATING THE CONCEPT OF "SOCIAL TECHNOLOGICAL SYSTEM"

In moving from topics to problems, we needed a theoretical framework to guide our actions in the field. We wanted use knowledge from our STS research to avoid problems that other groups and social movements had encountered when attempting to incorporate a technological dimension into strategies to solve problems associated with poverty, exclusion, and underdevelopment. We understood that technologies already play key roles in processes of social change. They outline actors' positions and behaviors, condition social and economic structures, generate processes of capital accumulation and income redistribution, enable or restrict access to goods and services, and create social and environmental issues and facilitate or hinder their resolution (Thomas 2009, 2010, 2012). A commitment to technologies for social inclusion emerged as a way to develop and implement technologies aimed at generating sociotechnical dynamics for social inclusion and sustainable development.

Framing technologies as a way to address poverty, exclusion, and underdevelopment had started in the 1960s with an interest in producing "appropriate" or "intermediate" technologies (Schumacher 1973). In general, technologies classified as such were of small scale (household or community) and low complexity, and drew on mature technologies, low levels of scientific and technological knowledge, low levels of investment, and low-cost inputs, with little or no relationship with the market. Yet most of these experiments had been interrupted, had failed, or had led to significant unwanted effects (Thomas 2009). In the 1980s, authors such as Rybczynski (1980) and Ahmad (1989) sought to get past the technological determinism of appropriate technologies, giving rise instead to "alternative technologies" (Dickson 1980). Over the next decade, new approaches emerged against the theoretical backdrop of the "economics of technological change," "grassroots innovation" (Gupta et al. 2003), "bottom of the pyramid" (Prahalad 2010), and "social innovations" (Martin and Osberg 2007). Nevertheless, each of these conceptual approaches had significant limitations that led to dysfunction and unwanted effects in their implementation. In addition to technological determinism, some of these effects included supply-side rationales, voluntarism, paternalism, nonintensive use of scientific and technological knowledge, lack of use of tacit and customary knowledge, inefficient use of economies of scale, specific solutions rather than systemic ones, misunderstanding of market relationships, and limits to market dynamics as the exclusive avenue for economic relationships (Thomas 2009, 2012).

Researching these critical outcomes became part of the group dynamic in the earliest stages of the new Quilmes team. Team members needed a concept capable of guiding the design and implementation of public policies for technological developments that directly addressed the dynamics of inclusion and sustainable development. This concept had to be a starting point, of course, a catalyst of coded knowledge for learning-by-doing experiences that could prove useful to the design of policies. The Quilmes team used the idea of "social technological systems" (Thomas

2012)[6] to guide its work. Social technological systems aim at generating dynamics for social and economic inclusion. Heterogeneous in terms of actors and artifacts, the sociotechnical dynamics of social technological systems democratize technological decision-making and sustainable development. The concept implies actions for the design of products, productive processes, and organizational technologies that focus on inclusive problem-solution relationships, especially the socialization of goods and services, democratization of control and decision-making, and empowering of communities of producers and users. The actions of social technological systems simultaneously pursue four sociotechnical commitments required for socially and economically inclusive development processes:

- achieve equality of rights
- dignify conditions of human existence
- generate new spaces of freedom
- improve standards of living

Yet how could such a concept become praxis? A theory of social technological systems cannot itself find concrete existence without a series of actions to develop technological solutions aimed at inclusive and sustainable dynamics. Such dynamics would not be the result of spontaneous generation. The research team would have to orient its actions toward the field of policy.

ADDING THE ROLES OF POLICY DESIGNER AND POLICY DOER TO THE RESEARCHER'S PRAXIS

In 2009, the National Council of Social Policies—an interministerial agency—decided that a strategic policy objective would be to provide access to water uncontaminated by arsenic in the Argentine territory and entrusted the S&T Ministry to carry out the objective. The ministry called on the Quilmes team because it was already working with the ministry on technologies for social inclusion.

About 80% of Argentina is arid or semiarid and almost 40% has high concentrations of arsenic in the groundwater. The national government had financed numerous research and technological development projects to solve the arsenic problem, without success. The first item for the Quilmes team to negotiate was the focus of the initiative. Might it be possible to move from working on access to quality water to addressing local systemic development as a problem of innovation and technological development (DAPED 2012)? This proposal met with no resistance.

The team proposed a project with the assumption that the S&T Ministry would execute it. However, once the general guidelines of the project were constructed, ministry officers said that the ministry did not possess planning or implementation capabilities in the territory. The ministry refers to itself as a policy and funding agency, not as one that does concrete work in the field. The question became who would execute it.

S&T Ministry officers were quick to argue that the Quilmes team should be part of and, indeed, coordinate the project. And given that there was interest from the Ministry of Social Development and from the INTA, the Quilmes team proposed that these administrative units establish a public-public consortium to implement it. That's when several political and bureaucratic problems began.

The S&T Ministry had intended to finance this initiative through a National Sector Fund for social development, using Inter-American Development Bank funds. It would charge the National Agency for Scientific and Technological Promotion to deliver the funds. This body had never financed a public consortium, however, and had also never provided a fund oriented to social development. There was not even a form on which to submit a proposal with these conditions. The problems quickly multiplied. As but one example, between 2009 and 2012 the S&T Ministry changed the project form twenty-one times, requiring the Quilmes team to present twenty-one different versions of the project. During these four years, there were several times we thought we would never get to do the work. After five years of negotiations with all parties, we finally got funding for the project. The S&T Ministry had initially called the Quilmes team a provider of technological "solutions," narrowly defined. During those five years, it became clear that providing solutions necessarily included challenging, reframing, and overcoming a range of bureaucratic barriers just to get the project started.

The team's first lesson was thus that, even with the political support of the Inter-American Development Bank and the highest national authorities, state bureaucracy lacked flexible procedures for intragovernment articulation and the financing formats needed to articulate and coordinate actions between government agencies. Not even a project implemented by two public institutions found space in government financing forms.

Although we were part of the government, we were excluded from the bureaucratic protocol, which impeded our ability to secure financing. The situation was solved not because the government procedures were amended but because, as nongovernmental actors, we managed to persuade the political stakeholders of the project's strategic importance to the S&T Ministry for future innovation in social development. In March 2014, the water project was finally born. It had an implementation unit (the Quilmes team and the INTA); it was supported by RedTISA, the Ministry of Social Development, and the National Council of Social Policies; and it was financed by the S&T Ministry. This marked another transformation of the Quilmes team, in this case adding the roles of policy designer and policy doer.

The water project had three objectives:

1. To generate a new mode of government intervention for improving the institutional capabilities of innovation and technological development aimed at sustainable inclusive development based on social technological systems;

2. To ensure access to goods and services in rural communities significantly lagging in development—prioritizing access to water, both quality and quantity—through adequate technological systems; and
3. To design intervention, education, and research models to enable the scaling up and replication of these experiences at the national level.

The scientific and technological challenge was explicit, and the priority was to learn in order to improve government intervention models of comprehensive development.

Project implementation began in March 2014 in five rural areas of the province of Chaco. Each area had distinct characteristics. Some were indigenous communities; some were areas with low-capital farmers or family farms; some had populations of goatherds, vegetable producers, or brickmakers; and some had water with arsenic and salts, low flow in local waterways, or agrochemical contamination. The rural communities of Pampa del Zorro, Colonia Aborigen, El Jacarandá, Colonia Cacique, and Pampa del Indio were impoverished, isolated areas with low population density.

Rather than attempting to summarize project dynamics in each community, we share here some of the key actions that the working group deployed in the field to design and implement social technological systems.

ESTABLISHING AND TRAINING LOCAL AND NATIONAL TECHNICAL TEAMS

One project goal was to create interinstitutional technical teams at national, provincial, and local levels, which could then communicate with and support each other. To that end, we had two decision-making bodies: (1) a national coordination team with representatives from all public institutions involved and (2) a local team in each project area, with the involvement of local actors such as municipalities, schools, farmers' associations, health care centers, and associations of indigenous communities. In order to achieve a common language to guide the work, the Quilmes team designed a cycle of theoretical-practical training in the design and strategic planning of a social technological system. All officials and technicians involved in the project completed this training.

The training spaces provided a central location to discuss, from a sociotechnical perspective, the ways in which technicians and officials of the INTA, the National Institute of Industrial Technology (INTI), and local municipalities design strategies for rural intervention. The training course aimed to modify those linear and restricted perspectives that fail to go beyond a specific technology or issue and thus do not lead to systemic development strategies at a local level. For instance, INTA technicians are not always familiar with each rural property or the area as a whole. They had worked with groups of farmers and confined their attention to specific topics to facilitate focused research or extension of a specific area of knowledge. The training courses helped participants come to appreciate the complexity and diversity

of development dynamics, including why an engineer also has to be an economist, a sociologist, or an anthropologist. It was not just a problem of deploying technological artifacts. It was a problem of constructing systems.

The critical analysis of linear or determinist thinking in conventional practices was rejected by some officials. We interpreted the difficulty as one of momentum in institutional and organizational cultures. Some teams of government officials who decided to discontinue their participation in the projects argued that there were no problems in the territories or that there was no need to improve methodologies of intervention. "The problem of poverty is a production and cultural issue. We have ways to address it. Why do we need another way of doing things?" said one government official. Time and time again, we found our work proposal and action plans to fall outside the rationales of existing public institutions. But we persisted. The Quilmes team developed a new set of social skills, especially learning to enroll and mobilize hierarchical actors. Most of the linear and determinist thinking was put aside when the political heads of the INTA and the National University of Quilmes asserted their authority on our behalf. Generated in the dynamics of learning by doing, these skills had to become routine parts of our work.

The Quilmes team initiated the training cycle and the research team made concrete the theoretical idea of social technological systems through their execution. At the same time, these organizational initiatives made it possible to establish creativity spaces more open to new mechanisms and work schemes and to redefine the scale of action on the basis of a broader view of territorial development. Also, the constant feedback from the national team generated new ideas for cofinancing the various proposals and for including new participants to help scale up the efforts.

LOCAL MANAGEMENT DESKS: A TECHNOLOGY FOR COMMUNITY ORGANIZATION

Another project goal was to democratize decision-making and control at local levels. To that end, it was necessary to create spaces for informed decision and dialogue that did not previously exist in rural communities with dispersed and isolated populations. The Quilmes team borrowed the idea of local management desks from the Ministry of Social Development, which had created such desks in urban areas and judged them to be a positive instrument for citizen participation (Ministry of Social Development 2013). The Quilmes team initially conceived the desks as a means for local actors—municipalities, rural consortiums, road consortiums, farmers' associations, school and health care officials, and community members—to come together to establish communication processes for planning and decision-making. However, for Quilmes team members, local desks raised a second-order question: What is our role in the desks? Do we control the desks, or are we participating as just one more actor? Could we introduce problems for a desk to add to its agenda, or must we step

back and wait for a spontaneous decision to emerge? To us, the obvious answer lay somewhere in the middle. We had to learn to approach the situation with only a semicontrolled plan of action.

For villagers, the local desks became a way to reestablish a sense of community while including us, the Quilmes team, as part of that community. When we first began working, a local villager, Alicia, told us, "For years we have not seen our neighbors. We do not know what they do. . . . Since we have been working together, we have been able to recover the community. Now we work together, and we solve our problems together. We can dream of a better future for us."

In Pampa del Zorro, the first issue its desk confronted was to define its problem agenda. Participants in the desk included local families, teachers from the public school, professionals of the INTA, and us. The families lived several kilometers apart in a subsistence economy, and they immediately identified lack of access to public services, including water, sanitation, and health. The school had deteriorated significantly from a lack of funding. Neither the INTA nor any national public body had ever worked in that location. So we suggested using the desk to generate a decision-making mode for designing and implementing a local development plan.

In our ex ante diagnosis about the situation of rural communities in the north of Argentina we had identified lack of access to safe drinking water as a main cause of underdevelopment pathways. We introduced that diagnosis at the first meeting. Although desk members identified access to water as the main structural problem in Pampa del Zorro, the more important, most urgent and most difficult long-term problem was the bite of the "vinchuca."[7]

We had known about the problem of Chagas disease, but we did not understand the pain produced by the vinchuca bite. For us, this shared problem became an opportunity. It allowed us to think effectively about a common work agenda in which heterogeneous actors could address shared problems. But Chagas disease also posed a significant challenge. We didn't know anything about how to deal with vinchucas. We had no money to fumigate the houses, and we didn't know how to fold our initial water problem into the vinchuca problem.

Risking distraction from water, the local desk decided with our support to implement house fumigation against vinchucas as its first collective action. The fumigation was carried out by each local area, one house at a time. This decision required a collective commitment to purchase fumigation equipment, using local funds and funds from the university. Working together to solve the problem led to mutual recognition and built confidence. Five years later, this initial move to collective action had borne many fruits. Each family had its own water system, new houses had been built, and the school was fixed. The families had created a producer association, municipality officers had become part of the desk, and the INTA had established a permanent work zone in the area, where collective fumigation still takes place. This desk became the most successful in the water project.

Each of the five local desks that were established defined its own core guidelines for commitments and joint work responsibilities, such as holding periodic meetings, making decisions on the local strategic plan, registering implementation monitoring and control, and maintaining means of communication. With the active participation of the Quilmes team, each desk developed social technological systems strategies in establishing parameters of design, redesign, and implementation.

STRATEGIC PLANNING OF SOCIAL TECHNOLOGICAL SYSTEMS

The core goal of the water project was to develop a new model for government intervention that would be capable of integrating local innovation dynamics to generate broad processes of sustainable and inclusive development. With that goal in mind, the water project team designed and adapted specific work methodologies and mechanisms aimed at operationalizing processes to achieve social technological systems. Some of these included the following:

- Instruments for population surveying and monitoring: One of the main problems in the design of inclusive development strategies is defining the target population. In Pampa del Zorro, for example, boundaries are fuzzy, which made finding the people difficult. We identified sixty-three families across an area of eight thousand square kilometers. In areas such as Colonia Cacique, much of the population is nomadic, and we worked with others to carry out a socio-habitational survey, a georeferencing of the population and water sources, and a photographic housing survey before launching the collective decision-making actions.
- Mechanisms for collective decision-making: Each community adopted its own model for decision-making. One chose raised-hand voting, another chose a lottery-like system, a third elected a representative, and two based their decision-making on ancestral criteria. In all cases, discussions were held as to what decisions implied in dynamic terms. Although the lottery[8] was the most impartial mechanism, it proved to be the least efficient and was later changed into a spatial planning-based decision-making mechanism. Under the lottery system, families built one water cistern in five days. With the new model, they constructed two water cisterns in three days. Each desk deployed its own criteria to balance inclusiveness, equality, and optimization of human and physical resources.
- Mechanisms for informed technological decisions and generation of sociotechnical capabilities: Building these capacities required (1) training the community in technological options, (2) practical training sessions for learning more about the technologies and assessing how they worked, and (3) collective reflection on the use, adaptation, and supplementation of technological systems (Juarez, Becerra, and Thomas 2018). Drawing on these experiences, the community of Pampa del Zorro deployed concrete water cisterns for each family, and the community of

Colonia Aborigen deployed a huge collective cistern of fifty-two thousand liters made with locally manufactured bricks.

- Funding sources: A key problem is finding a continued flow of funding to build up the sociotechnical system, including access to water, health, production of good and services, education, sanitation, and housing. The Quilmes team worked with both the INTA and local communities to foster fund-raising skills.

Developed in an ad hoc way and adapted to each case, each instrument was oriented toward producing better-quality information, ensuring the collective and participatory nature of the process, and strengthening local capabilities for generating knowledge and innovation, mainly by stressing the analysis of technological options and the social adaptation of technological systems.

Operationalizing local strategies produced action in two steps, an urgent intervention followed by a structural intervention (DAPED 2014). Speedy resolution of access to water became a top priority in all cases, because access to water is a fundamental human right that should be guaranteed by the state. Early interventions purposely took place in public spaces, such as schools, community centers, and healthcare facilities, in order to demonstrate the associative and collaborative nature of the proposed process. Public action also made clear the importance of generating local technical capabilities, including theoretical-practical training in masonry, electricity, and water technologies.

Following that initial step, the structural intervention strategy was deployed. It included the design and implementation of systems oriented toward sustainable inclusive development at the levels of both the household and productive unit and the community.

In community terms, focusing on sociotechnical systems rather than artifacts alone generates dynamics at different levels. Among families, a new sense of engagement emerged with the territory and its institutions. “Now we can say to my son,” said Alicia, “that here [in this rural area] he can make his future.” And Cholo, the president of a local producer association, said, “We are very proud of our rural school. We worked together to provide water to the children.” At the level of the municipality, public officials found new ways to work with isolated rural areas. A civil servant of Las Breñas Municipality told us, “After two years of working together, now we know how to use our limited budget to bring services to our rural population.” In the official teams, INTA officials and Quilmes team members were able to generate new intervention models to scale up the scope of sociotechnical solutions.

BUILDING R&D CAPABILITIES BASED ON PROBLEMS IN THE FIELD

The construction of multiple community maps of the problem-solution relationship was aimed at deconstructing the monodimensional view of problems and putting forward systemic sociotechnical solutions. We discussed each problem and each solution with the community, and each community prioritized a unique agenda

of topics (Matus 1988). Moreover, each community identified relationships among themes and technological systems in order to generate a systemic approach to solving the problems. Collaborative networks, based on problem-solution relationships, were created to promote new technological and institutional capabilities, as well as capabilities for interinstitutional articulation and coordination at the local level.

Working with partners, the Quilmes team developed a *methodology for informed decision-making and local sociotechnical adaptation*. This methodology comprises a pool of technologies (artifacts, processes, and organizations) preselected by the technical teams on the basis of the community's priorities and the relationship between locally established sociotechnical problems (Juarez et al. 2016). Communities receive theoretical and practical technological training and courses of action are established according to their collective assessment.

Technological options are linked to certain collaborative networks—that is, other institutions or people with techno-cognitive capabilities that are associated with the development and implementation of a certain specific technology or knowledge. These networks were important as a means to collaborate with the communities in the design of the sociotechnical systems, both when broadening the range of technological options and when thinking through possible complementarities among technologies. The communities organized and implemented a large share of the local interventions. This local emphasis reinforced decision-making and collective action, reaffirmed local technical capabilities, and enabled social learning not only about artifact technologies, but also about such organizational technologies as supply purchases, logistics, time allocation, and work team establishment.

The modalities used for intervention in the communities made it possible for some technicians from the INTA to rethink the ways they work in the field and begin looking for the capabilities needed for local strategies, beyond the capabilities available in each institutional unit. Thus, the techniques and methodologies became a source of instrumental support to overcome the linear problem-solution relationships that dominate current public policies and the approaches to technologies for inclusion that we had detected when reformulating the research agenda. Even these government officials began to develop new capabilities for systemic intervention. The various activities carried out under the water project have made it possible to enhance public policies and available technical knowledge beyond the project's territory.

Developing social technological systems means deploying "reapplication" dynamics—that is, avoiding practices of technology replication and the uncritical generalization of technologies. The idea is for learning generated in one place to be sociotechnically[9] adapted to others, in terms of both policies and technologies (RTS 2011). To this end, the water project established in one of its community projects a scale-up strategy that used the first community as a pivot. Using peasant-to-peasant methodologies (Holt-Giménez 2008), the local team created spaces for communities of learning with neighboring locales, inviting them to take part in

the technological training processes. Some groups in Pampa del Zorro and Colonia Aborigen traveled to neighboring locales to convey their experiences in constructing local strategies. The theory behind this radial strategy involves gradually promoting the capabilities and resources needed to work in new rural areas, with the same water project technical team, and using the neighboring community's experience to generate emulation.

At the national level, the coordinating body for the project designed a research activity in all twenty-four Argentine provinces aimed at creating new inputs for policy decision-making around water, titled "Management of Scientific-Technological Lore and Knowledge for the Resolution of Water-Related Issues in Argentina: Survey, Systematization, and Analysis of Learning in Management, Technologies, and Regulations" (Juarez et al. 2016). The water project has also become part of the transnational SEDCERO program, a collaborative network of public and private organizations from Argentina, Bolivia, and Paraguay. The main goal of this program is to influence public policies to improve water and sanitation services and to develop integrated water management mechanisms for the region. With its commitment to social technological systems, the water project has produced learning that has informed local, national, and regional policies.

SOCIOTECHNICAL ALLIANCES IN THE WATER PROJECT

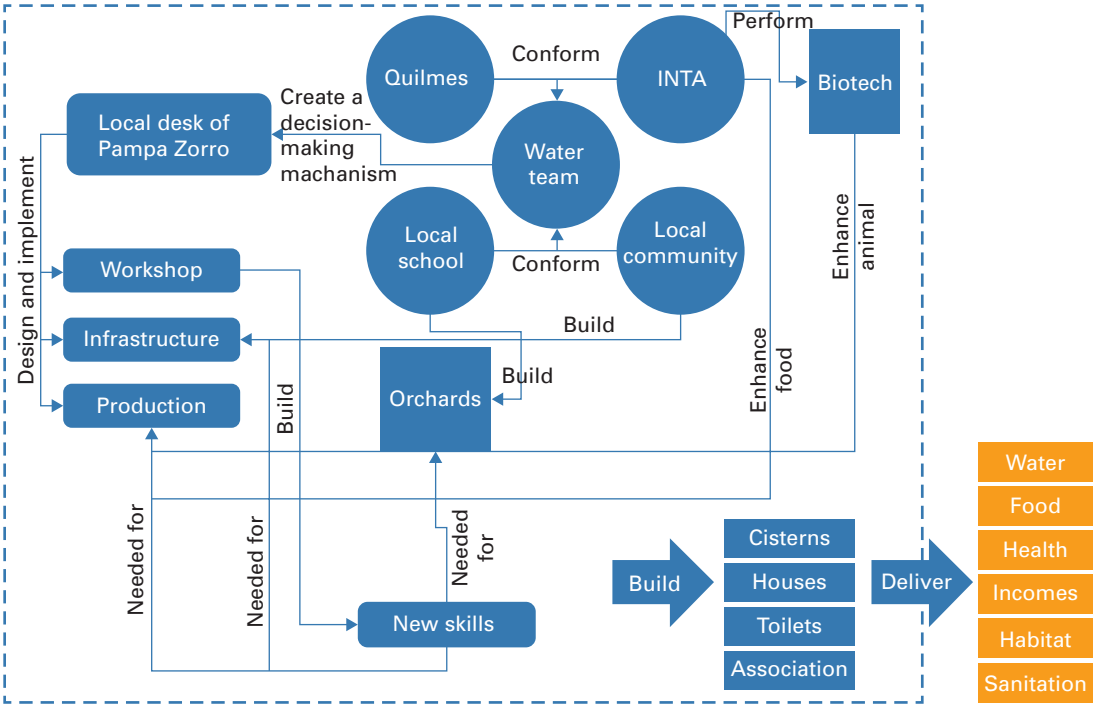
The water project's commitment to technology and social inclusion revealed a new set of problems related to how policy is made within government. Put bluntly, the policy process for designing, implementing, and evaluating projects was broken within both the S&T and Social Development Ministries. The link between the ministries is the research team, and thus the weakest element in the entire system is the concrete policy actor, the group of STS researchers. This situation represented a challenge for us in terms of integrating new learning strategies at the institutional level while working in the margins of the political system and in a very imbalanced power relation. At the same time, however, our identity as academics empowered us because policy makers saw us as neutral actors.

In both ministries, policies were designed from the top down; those affected by the policies had no role in their design. Design and implementation were carried out by different groups, and neither had officers to implement the policy decisions in other institutions, such as the INTA or nongovernmental organizations. Once again, we as researchers had to take the lead in implementing policies.

By taking the lead, we could examine the socioeconomic dynamics at the local level and implement our own strategy of field work. The Quilmes team designed a territorial intervention strategy, implemented it, and then learned from that experience in order to generate new instruments. In other words, the Quilmes team couldn't just give advice to the ministries on programs or instruments if we wanted the social

technological systems designed and deployed. According to that approach, "we" are the agents who deploy the policies in the field. "We" are policy designers and policy doers. "We" would be the learning unit. And "we" is in quotation marks because there was a social group behind the "we" that was bigger than the Quilmes team (INTA, municipalities, local communities, etc.).

Building sociotechnical alliances thus became an important step in constructing social technological systems oriented toward inclusive development. Consider, for example, the arrangement of sociotechnical alliances in Pampa del Zorro (figure 4.1). The water project team is integrated by different actors—the Quilmes team, INTA, local school, and local community—and implemented a local desk for decision-making. The desk deployed a range of actions. It carried our workshop for skill generation, including electricity, masonry, woodwork, and good practices of animal management. It built up infrastructure, especially water cisterns, toilets, improvements at the public school, and in houses. It generated new food production, particularly with organic orchards. The new system achieved important new dynamics. Each family has its own source of water. The whole community of Pampa del Zorro has a collective mechanism of small animal management. Families have toilets and showers. Kids in school receive better nutrition and improved sanitation. Houses are stronger. And most important, the residents have produced a community with its own mechanism of collective decision-making.



4.1 Sociotechnical alliances in Pampa del Zorro.

RAISING THE STAKES: BACK TO THE STS FIELD

In this account, we show how the strategic decision to inflect public policies with the goal of fostering dynamics for sustainable inclusive development produced a trajectory of transformation for the research team. This trajectory included modifying the research agenda (from history of technology to a social problem setting), integrating policy design processes (during the work in the water project), and deploying technologies (especially new ways of organization) in the field.

Conceptual development was fueled by the new praxis, just as the praxis required leaving behind descriptive and analytic notions in favor of more planning-oriented concepts. In addition, these concepts revealed their usefulness for addressing a multiplicity of analytic objects. These included sectoral dynamics (durable goods, health, metalworking, aerospace, the pharmaceutical industry, nuclear power, and so on), scientific and technological policies, and research and development and innovation strategies (both at national and regional levels and at institutional ones). They also included new contributions to scholarly disciplines such as cultural anthropology, economics of technological change, history of S&T, sociology of technology, development policy, and S&T policy and management. At the same time, academic papers now constitute just a portion of the documents produced by the Quilmes team. Adding the roles of policy designer and policy doer to the research has led the Quilmes team to also produce policy documents (to inform public instruments), public communication of research outputs, training materials (for undergraduate and postgraduate courses) and, since 2017, an entire postgraduate university program, Planning and Design of Social Technological Systems.

Far from a practical agenda that competes with the academic one, the implementation of this research strategy generated new possibilities of development at the sociopolitical and socio-cognitive levels, both theoretically and empirically, as well as academically and politically, as two sides of the same coin: greater commitment and relevance on one side of the coin and higher quality and excellence on the other. Far from competing, the two sides were complementary.

Almost ten years after the beginning of this transformation, we can now say that this working group has reconfigured its idea of what research is. We now understand "research" as generating knowledge that is useful, collective, associative, and nonalienated for both public policies and organizations in the various territories. Research, for us, entails looking for a way to influence the political agenda when prioritizing thorny issues and when solving them. Research entails training decision makers in constructivist and sociotechnical planning methodologies. In addition, after ten years, the Institute of Science and Technology Studies of the National University of Quilmes—which was already a national and regional reference center for social studies of S&T—is now also a key institution in technologies for sustainable inclusive development. Over time, the research agenda and territorial action has become even

more diverse and challenging, now including water, sanitation, and urban and rural development; circular economy, inclusive recycling, and social innovation; renewable energies and distributed generation; comanagement of national parks and empowerment of native communities; and evaluation systems of S&T institutions.

The work we did with communities, grassroots organizations, cooperatives, trade unions, policy makers, and even the academic community has generated knowledge commitments that have become irreversible. Designing is not about technologies for the poor but about strategies for the inclusion of all in possible and desirable futures. Or better yet, in possible new and desirable futures. And during the journey the critical analysis of the theory and continuing reflexive action over our own practices has been decisive at those times when we could not find answers to the problems before us.

Latin America still has many issues of underdevelopment, poverty, and violence. These problems will not be solved unless different social groups, including academia, become actively involved and set themselves to work in a coordinated fashion. And although established knowledge is a key tool, being willing to learn to solve new problems with others is central to the construction of solutions that are sociotechnically adequate for the territories. The field of science, technology, and society can play a prominent role in this learning scheme aimed at solving social and environmental issues. A critical view of scientific and technological dynamics is central to avoid ready-made, universal, and politically neutral solutions.

The challenge is thus put forward. The only thing left to do is raise the stakes.

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NOTES

1. See the ministry's website at http://www.mincyt.gob.ar/estructura-ministerio (our translation).

2. The senior researcher was Hernán Thomas, a coauthor of this chapter, who in 2011 became director of the Institute of Science and Technology Studies at the National University of Quilmes.

3. One of those junior researchers with experience in appropriate technology was Paula Juarez, a coauthor of this chapter, who arrived at the institute following a previous journey as a social activist. Appropriate technology is small-scale, affordable, locally autonomous, and energy efficient.

4. In 2010, Lucas Becerra, a coauthor of this chapter, started work with the Quilmes team.

5. For additional information, visit the RedTISA website at http://www.iesct.unq.edu.ar/index.php/en/redtisa.

6. Construction of the notion of social technological systems occurred simultaneously with the resetting of other analytic concepts used by the team—for example, the notions of "working/non-working" (Pinch and Bijker 1987), techno-economic networks (Callon 1992), and agency (Latour 1989). They were combined in a new concept, "sociotechnical alliance," This term refers to coalitions of heterogeneous elements that become part of the process of building the working or nonworking of a technology. Sociotechnical alliances are dynamic associations of alignment and coordination among artifacts, ideologies, regulations, forms of knowledge, social actors, economic resources, environmental conditions and materials, and so on. The constitution of sociotechnical alliances makes stabilization and assignation of meaning to certain technologies viable or unviable (Thomas 2012).

7. Locally, *triatoma infestans* (kissing bug) is called "vinchuca." It is a heteropter insect of the family *Reduviidae*, hematophagous, and one of the vectors that transmit Chagas disease. In Pampa del Zorro, the entire population suffers from Chagas disease.

8. The lottery system consisted of putting pieces of paper in a bag with the names of each family and then drawing out ten names at random. The order in which the names left the bag determined the order for allocating construction materials to each family.

9. In sociotechnical adaptation, technology production is a self-organized and interactive process that integrates a lore, artifact, or technological system in a sociotechnical dynamic or trajectory that is sociohistorically situated. This process integrates problem-solution relationships, working/nonworking, coconstruction dynamics, development of technological frameworks, reinterpretation of technologies, technological styles, and so on (Thomas 2008b).

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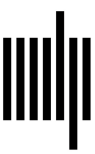

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