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Bram Bos and John Grin

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"Doing" Reflexive Modernization in Pig Husbandry

The Hard Work of Changing the Course of a River

Bram Bos
Animal Sciences Group, Lelystad, and University of Amsterdam, the Netherlands
John Grin
University of Amsterdam

The Dutch animal production sector faces significant pressure for change. We discuss a project for the design of a sustainable husbandry system for pigs. Named after the Greek hero Hercules, the project aimed for structural changes in both animal and crop production. However, instead of changing the course of the river, the project ended up merely adapting its flow. The Hercules project ran into difficulties typical for projects aiming at reflexive modernization. It relapsed from an effort for reflexive modernization to ecological modernization, by ultimately leaving the structural features of the sociotechnical regime intact. We show how this resulted from the biases and limitations implied by existing institutions, in which the project was unavoidably embedded. We introduce the idea of reflexive design, as "doing" reflexive modernization, which implies working on action and structure at the same time. A number of recommendations are given for reflexive design projects like this.

Keywords: *sustainable development; reflexive modernization; ecological modernization; agriculture; animal husbandry*

In recent years, the Dutch agrofood sector, especially the segments focusing on animal production, have become the object of significant pressure for change. The manure and emission problems and animal welfare concerns (e.g. chicken housing) had already attained themselves a firm place on the public and political agendas, both nationally as in the European Union. Until around 1997, it was generally thought that these problems could be solved through adaptation by technical innovation accompanied with and

induced by strict regulative policies. The dominant discourse was that of *ecological modernization* (Hajer 1995), or the belief that environmental problems can be solved without touching the structure of our production systems.

However, the classical swine fever (CSF) epidemic between February and September 1997 gave rise to the suspicion that something was more fundamentally wrong with the existing regime of intensive husbandry, not only in the pig sector but also in other sectors. In this article, we will discuss the so-called *Hercules* project, an innovation project to design a radically new pig husbandry system that resulted from that era. Named after the classic Greek hero Hercules (a.k.a. Heracles) who cleansed the stables of Augias from thirty years of manure by changing the course of two rivers, this project aimed at a radical improvement of the way pigs are held for meat production, including improved animal welfare, a considerable reduction of the environmental burden of intensive pig husbandry, and the conversion of manure from waste into a product with commercial value.

Over its lifetime, subsequent crises have been going on: the Bovine Spongiform Encephalopathy (BSE) outbreak in the Netherlands (peaking there in 2000, following a peak in the UK in 1996); Foot and Mouth Disease (2001); the affair with polluted animal feed containing the illegal hormone MPA touching the pig and calf sectors in 2002; and, more recently, the Avian Influenza epidemic of 2003. These developments, together with a number of other societal considerations casting doubt on the legitimacy and long term viability of livestock production at large, created a sense of urgency for the need to reform it: within government (e.g. Denkgroep Wijffels 2001), societal organizations (Dierenbescherming, Stichting Natuur & Milieu, etc. 1997) as well as—although reluctantly and hesitatingly—in the sector itself (LTO Nederland 1999, 2001). More precisely, the awareness was growing that this whole range of "unintended side effects" could not possibly be solved by a mere adaptation of current knowledge and technology, farming practices, legislation, and consumption practices, but demanded a more thorough scrutiny of the presuppositions on which the sector had thrived for decades.

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We interpret this (see Loeber 2004, 1-28) as the felt need for reflexivity in the way Beck (1997, 78) uses it: society becoming "an issue and a problem to itself." This growing awareness has certainly influenced the Hercules project, but it did not suffice to alleviate some of the more obnoxious problems that were encountered, and will be discussed below. We take these problems to be typical for the challenges involved in what Beck has called *reflexive modernization* (Beck 1997; Bekke and de Vries 1994; Beck, Bonns, and Lau 2003): using the best of our reason to preempt and mitigate side effects while maintaining the benefits of earlier modernization efforts. As Latour (2003, 46) has pointed out, Beck's notion of reflexive modernization (or *Re*-modernization) is ambiguous. It is prescriptive, as a master-narrative on how modernization could be done better. But Beck also claims it to give an adequate description of what is actually going on. Latour's conclusion is "that the data to be gathered to prove the advent of a substantial phenomenon called *Re*-modernization are not easy to come by and, so far, are not thoroughly convincing." (2003, 45) Thus, Latour concludes that *Re*-modernization should be seen as a prescriptive master-narrative, that is powerful enough to shift the "attention from the mainstream to the discrepancies, failures and side-effects," in that way fulfilling its own prophecy.

We think we lose an important characteristic of the concept if we try to resolve its inherent ambiguity, like Latour does. On one hand, reflexive modernization might very well be a form of modernization actually occurring in parallel with other attempts for modernization, like ecological modernization, making it much more difficult to discern and empirically identify it as a meta-change. On the other hand, Latour seems to be too optimistic about the power such a master-narrative or vision might have in shielding actors involved in projects of reflexive modernization from the influences of the mainstream or dominant regime. If we take this into account, reflexive modernization is neither to be seen solely as a master-narrative, nor as a, more or less smoothly, ongoing process of societal change, but as a concept that primarily refers to a program of "doing" reflexive modernization inspired by a particular vision on how progress might take a new form without disregarding the lessons of the past.

"Doing" reflexive modernization, given the very nature of the concept, implies hard work. As Beck (1992) has argued, risk society is not merely characterized by the fact that we can no longer ignore side effects and risks associated with modernization processes through which we have achieved social and economic progress. More important than the mere existence of such adverse consequences is the fact that the rules and routines embodied in current institutions—which developed around and are tailored to guide

progress-seeking modernization processes—do not provide adequate guidance for dealing with risks and side effects. Reflexive modernization thus involves changes in both action and structure.

The "duality of structure"—structure is both the medium and the outcome of action; cf. Giddens (1984)—indicates that, in principle, such "system innovation" is possible: as Fox and Miller (1996, 91) put it, this notion implies that "recursive practices" may be transformed through "discursive will formation." In this article, we understand the Hercules project as an attempt to do so. As we will argue, the difficulties encountered in the project can then be seen as reflections of two challenges that also are implied by the notion of the duality of structure. On the one hand, as structure has evolved around recursive practices, existing institutions will hardly offer an appropriate context for discursive will formation. As Hajer (2003) has argued, this problem of the "institutional void" implies that adequate institutional spaces must be "wrought" in the process. Paradoxically, such spaces for discursive will formation will unavoidably be embedded in existing institutions, from the influences of which they cannot be entirely shielded.

Analyzing the Hercules project in these terms, we aim to contribute to the development of a "middle range theory" model to understand processes of "doing" reflexive modernization. We will call this "reflexive design" (Grin et al. 2004), that is, those design methods and practices oriented toward a redefinition of existing functional differentiations between politics, the market, and society as well as within these subsystems. Reflexive design thus entails the practice and methodology of doing reflexive modernization, based on an adequate understanding on how action and structure interact with each other. The Hercules project serves as a case to show that it requires hard work to prevent such efforts of doing reflexive modernization from a relapse to a type of modernization, like ecological modernization (Hajer 1995), that does not explicitly challenge structural features of the existing regime.

A good starting point is the multilevel perspective (Rip and Kemp 1998; Schot 1998), in which developments on three levels are distinguished: niche experiments, which are more or less "liberated" from the rules pertaining to the existing regime; the regime level; and what they call the landscape, exogenous trends that may influence developments on the other two levels. Hoogma et al. (2002, 198 *ff*) have proposed to use this model as a basis for understanding "transitions" and "system innovations," that may be defined (Grin et al. 2004; Rotmans et al. 2005) as the reflexive modernization of sociotechnological systems.[1] Meanwhile, some studies have yielded important insights into the patterns through which developments at these three levels may merge into transition or system innovation (Kemp, Rip, and Schot 2001;

Geels 2002; Raven 2005). In addition, Roep, van der Ploeg, and Wiskerke (2003) have focused on the agency involved in bringing such patterns about. They argue that this involves "effective reformism," strategically connecting developments at the three levels through developing novel modes of self-governance, in new sociotechnical networks, synthesizing knowledge stocks.

With our analysis of the Hercules project, we wish to add insight into the ways in which the regime "talks back," to use Schön's (1983) metaphor, against such attempts at effective reformism. First, we describe the proceedings of the project, based on internal as well as published documents from the project, and eleven interviews with respondents from the various categories of participants.[2] It will be shown how the project was inherently ambiguous in its ambition of *doing* reflexive modernization.

Secondly, we focus on the tragic fate of the manure belts in the design—a specific technical feature, that implied structural rearrangements around the husbandry system. Next, we relate this specific history to the institutional difficulties originating from the existing regime that the project encountered, and try to answer the question why the project was not able to deal with these difficulties more adequately. Finally, we draw a number of methodological and theoretical lessons to make clear how the prescriptive and descriptive aspects of reflexive modernization are intertwined in reflexive design projects.

Crises and the Call for Systemic Innovation in Dutch Agriculture

The increasing realization that the major problems in animal husbandry were at least partly attributable to the regime of intensive husbandry came as a shock to many involved. Since late nineteenth century, the Netherlands has worked hard to "import" the scientifically based intensive agriculture from the United States. In the final quarter of that century, the increasing amount of grain and animal products that entered the country from overseas, together with the qualitatively superior husbandry products from Normandy, Schleswig-Holstein, and Denmark created an agricultural crisis. Under pressure of the primary sector, that had just started to organize itself, government left the hitherto followed policy of leaving agriculture to the market and established, in 1886, the Agricultural Commission.

The Commission's recommendations led to the start of agricultural policy as well as to a significant extension of institutes for the generation (research) and dissemination (higher and lower education; farmer information) of advanced knowledge and technology which since became the driving

force of agricultural development (Bieleman 2000, 13-19). Technology and knowledge development were focused on product improvement and, especially, land saving. Also, policy measures were oriented toward dealing with those problems. For instance, qualitatively superior pigs were imported from Denmark; knowledge and infrastructure for further breeding them were developed; and payments to farmers took quality into account.

After World War II, the problem definition of agricultural policy changed. Virtually upon taking office, the first postwar Minister of Agriculture, Sicco Mansholt—a social-democrat gentleman farmer from a politically engaged family (Westerman 2001)—started a major agricultural reform. (Bieleman 2000) Against the background of the "Hunger Winter" trauma of the final year of World War II, the problem was (1) to ensure sufficient domestic production of food that (2) would be available for affordable prizes. To relieve the tension between these two objectives, a detailed market and prize policy (including product subsidies) was introduced that made it possible to ensure farmers a good price while keeping food products well affordable for all consumers. So as to ensure that these subsidies would be a temporary provision, Mansholt strongly promoted the further modernization (or, if you like: industrialization) of agricultural production.

Thus, unlike the prewar period, labor saving became a prime objective of knowledge and technology development. Together with adaptations in water management (needed for the soil to be able to carry increased densities of cattle and machines) and land redistribution this led to rationalization in the form of concentration and specialization. The primary sector's share in the labor force decreased from 19 percent in 1947 to 5 percent in 1990, while the amount of capital goods (machines, cattle, buildings) increased by 80 percent. (Bieleman 2000, 17-63; Priester 2000, 65 *ff*) Within decades, virtually no "mixed farms" with both animal and crop production were left; even stronger, a further specialization occurred toward farms that only breed or fatten pigs, or keep cows or poultry—the latter two either for meat or dairy products. While the number of animals increased over time, the number of farms decreased significantly. In the pig sector, for instance, while the number of pigs kept roughly equaling the growing number of human inhabitants, the number of farms breeding pigs reduced from 275,000 in 1950 to 110,000 in 1975 and to 20,000 in 1995. (Bieleman 2000, 20) In addition, food chains became longer and more complex. Farms increasingly focused on the function of actual animal holding or crop cultivation, other tasks becoming the domain of other players, specialized in (knowledge intensive, advanced) activities feeding into the farm or processing and distributing its products.

Institutional development also included two crucial triangles: governance of the system was entrusted to an "Iron Triangle" of the Ministry, agricultural specialists in parliament and farmers' associations and the generation and dissemination of knowledge and technology was the role of the "OVO-triad" (a Dutch acronym for research, information, and education). While this system had already been targeted during the 1980s (Bekke and de Vries 1994) under influence of concerns about overproduction, animal welfare, and emissions, it was the crises of the 1990s that led to pledges for "system innovation," a catch phrase put on the agenda by the then national Advisory Council for Agricultural Research (NRLO) for a reflexive modernization of agriculture. Yet, agricultural policy remained mixed: in addition to some attempts to realize such a system innovation, there were also more technocratic attempts to deal with the criticism as well as tough measures to reduce pig farming through "reconstruction policy." The Hercules project which we are about to discuss was, interestingly, part of both a reflexive and a more traditional, first modernity government program, while its course was significantly influenced by reconstruction policy.

Hercules: An Innovative Housing Concept for Pigs

The Hercules project (Ogink et al. 2001; evaluation in Bos 2003) was intended to develop and test a new concept for pig housing and the production of an alternative for artificial fertilizers. From the start, the project aspired to solve a range of problems with pig farming at once by seeking a narrow integration of functions within the housing system. These problems included energy use, emissions of ammonia and odorous gases to the environment, the costs of getting rid of the manure, and animal welfare concerns (climate, slatted floors, lack of straw, etc.).

Hercules originated from the idea—conceived in the time of the manure debate by a researcher at one of the national agricultural research institutes Instituut voor Milieu en Agritechniek (IMAG)[3]—that the use of urine and feces in agriculture could be much more improved, if they were maintained and processed separately, since their mineral composition differs significantly. However, in modern husbandry systems for pigs, the two are mixed directly after excretion in the sewage system beneath the floor. The original solution for this in Hercules was so-called *manure belts,* running under the partly slatted floor. The convex shape of these belts enabled separation of liquid and solid excrements. Subsequently, "drying" the urine by using the

energy produced by the pigs and composting the manure would result in two attractive organic fertilizer products for agriculture that could be applied in a precise and specific way. Instead of paying to get rid of the manure, pig farmers could possibly be paid for this product.

Additionally, and unlike traditional sewage systems in which straw tends to hamper the manure streams, the manure belts could transport the manure out of the pig house, even when it contained lots of straw. Straw is—both by the general public and experts in ethology and animal welfare—seen as a positive contribution to animal welfare. Thus, the belts can be seen as a nice example of what Simondon (1958) calls *functional compatibility*, indicating the ability of a device to perform different functions at once. The Hercules concept features more instances of *functional compatibility*, like a device that simultaneously dries urine and cleanses the air from ammonia and odorous gases, getting its energy from energy produced by the pigs or a biomass composting unit, which reduces the amount of manure to be transported, while producing energy at the same time.

Thus, multiple goals oriented toward transforming pig production could be realized by combining several functions in the pig house through an integral design. The concept was explicitly oriented toward significant improvements in environmental performance and the quality of life of pigs, alongside with providing an economically viable new concept for pig production. Also, as we will see, these improvements could not entirely be realized within existing, institutionalized boundary conditions. In these two respects, it could be characterized as a project for reflexive modernization. However, as we will also see, in practice few people involved in the project were fully aware of its reflexive aim. This increased its susceptibility to the difficulties inherent to reflexive design.

Hercules started in 1998, funded by *EcologyEconomyTechnology* (EET), a governmental funding program from outside the agricultural realm that was to promote sustainable development through strategic R&D.[4] From its start, Hercules was a combined effort of six companies, ranging from manufacturers of pig house components to a chemical multinational and three different agricultural research institutes, oriented to fundamental (Wageningen University), strategic (IMAG) and applied research (PV Lelystad and Praktijkcentrum Sterksel), with knowledge workers from various disciplines. The project acquired additional funding from two different governmental programs. The first involved a research program for system innovation of the pig sector. The second was *Program 348: New Husbandry Systems* (P348), another policy response to the CSF crisis. Unlike EET, P348 stressed the importance of deliberation with a wide range of stakeholders. Early in the P348

program the decision was taken to use the method known as Sustainable Technology Development, as developed by the Dutch interdepartmental agency with the same name (cf. Weaver et al. 2000; Green and Vergragt 2001; Partidario 2002). Central to that method is the collective, deliberative development and realization of future visions to guide "processes of technological, cultural and structural change." Subsequently, a roadmap for development can be derived from these visions, using "backcasting." The entire P348 team was trained to use the Sustainable Technology Development (STD) method, further elaborated with the method of interactive technology assessment (ITA), the latter of which explicitly introduced a deliberative approach in managing these processes. (Grin and van de Graaf 1996; Grin, van de Graaf, and Hoppe 1997; cf. Grin et al. 2000 for its use on visions) Thus, although not originally conceived as such, P348 turned into a program for system innovation, and rapidly became to be seen as such by its steering group and management team (Spoelstra 2002). The (second) Hercules project leader was also part of this team. His grown commitment to a more reflexive approach resulted in a partial change of the course of Hercules around 2001. Although farmers had been consulted during some meetings early in the Hercules project, adoption of a deliberative approach introduced a stronger commitment to stakeholder participation and market perspective into a project which was until then a largely technically oriented enterprise.

These two different funding programs (EET and P348) thus introduced an interesting ambiguity in the Hercules project itself. On one hand, it can be characterized as a traditional innovation project, oriented toward a further modernization of pig production although now within the specific discourse of ecological modernization. On the other hand, it was an attempt for reflexive design, since the project's goals included structural rearrangements in animal husbandry and crop production from the start. In a later stage, the project took this hitherto implicit assignment more seriously, by deliberately seeking to break open hitherto unquestioned assumptions by an increased interaction with other stakeholders and the market. In the next section, we address two—interdependent—examples of the implications of these ambiguities: the ill fate of the manure belts in the concept, and the half-hearted engagement with the "second product" of Hercules: valuable organic fertilizers.

How and Why the Belts Were Dropped

As said, the manure belts were initially considered to be a key technique of the Hercules concept, connected to at least two of its core characteristics:

turning the "problem" of manure into a benefit and improving the living conditions for pigs. The key role of the belts was communicated as such, for instance in the special *Hercules Newsletter*. This perception of the belts by the team members and steering committee lasted for at least three years. In this period, the project's emphasis was on fundamental and strategic research—the proof of the principle—with little consideration for economical and market considerations.

The latter changed, however, in the course of the project. The project leader's choice to follow a course on the STD method just before he took over project responsibility, together with the fact that further P348 funding was explicitly bound to the application of the STD method, had an impact on the design of stage 2, in which means were dedicated for things like communication, user perception, and stakeholder involvement. At least as important, as the project progressed the future marketing of the concept got a more important place on the project's agenda. The firms participating wanted to speed up the process of going to the market, to get their return on investment: the most involved firms, while innovative and strong players in the sector, lacked the breath to sustain strategic R&D for years.

Unfortunately, the competitive advantages of a system like this compared to traditional systems became a matter of concern, for a number of reasons. First, it would be the first integral system to be sold in the Netherlands. Hitherto, it had been an entrenched practice of pig farmers to build their own livestock systems from their own selection of components, picked from a range of producers.[5] Buying a system would be a break with this culturally embedded tradition, typical for the specialization processes during post-war agricultural modernization (section 2). Furthermore, it turned out that none of the participating firms was able or willing to market the system as a whole, because of their scale and degree of specialization. The fact that a concept like this could not be protected in a meaningful way by patents made things even more difficult.

Secondly, it was supposed that the extra costs connected with the new techniques that were applied would be compensated by the replacement of costly manure removal toward the production of valuable and specific organic fertilizers. However, as the project proceeded, the manure market made an adverse turn: instead of manure becoming more expensive to get rid of, it got cheaper, partly because of the fact that more pig farmers than expected ended their business as a consequence of the policy to reconstruct large areas of the countryside (*Reconstructie*). This would have been less serious if a viable marketing channel and an application infrastructure had been developed. Organic fertilizers have to compete with cheap compost

from household organic waste and artificial fertilizer, which acquired dominance in modern agriculture because of the easy and specific ways it can be applied. In theory, the new organic fertilizers to be produced in the Hercules concept could accomplish similar things. In practice, this also required measures like developing new application machineries for the liquid urine fractions, making farmers procure them and changing the fertilizing habits of agricultural farmers. In other words, the success of the Hercules concept in the *animal* production market depended on a systemic innovation in *crop* production, as well as on interaction between the two. As another reflection of postwar modernization, these had become worlds of themselves though—in terms of agricultural practice as well as in the knowledge infrastructure around it. Both the firms and the research institutes participating were primarily oriented toward animal production; setting up a cooperation with parties "from outside" was, at the time, considered too time consuming. And even when knowledge on animal and plant production was present in the same institute—as was the case for IMAG—this expertise resided in different departments that neither communicated nor cooperated easily.[6]

Thus, the cost-benefit ratio of the Hercules concept increased: by the end of the first pilot, it was calculated that the costs per kilogram of meat would be € 1,42, compared with € 1,37 for a more traditional pig house. This was seen to be unacceptable in the market, especially since there was little confidence that consumers would be prepared to pay for improvements in animal welfare. Every part of the concept was scrutinized by the project team for its relative contribution to the overall cost. The manure belts turned out to be a major factor in the increase in investment costs for the system. These costs played a major role in the decision to discard the belts, especially when it became clear that the enlarged size of the pig boxes adopted meanwhile would require wider or double manure belts.[7] However, cost of a component in itself was not enough reason for the steering committee to continue or abandon that part of the concept in the second pilot. A variety of reasons finally led to the decision to leave the belts out, but not without lengthy discussions within the project: for years, the belts were felt to be too symbolic for the integrated and innovative character of Hercules to abandon easily.

One of the reasons was the "discovery" that at least some pig farmers had a deeply rooted resentment against technique under the slatted floor. As a member of the project team, from an institute for practice-oriented development, said:

> Well, imagine something breaks down and you have to get at it. There are twelve pigs, [with an] average weight [of] 60 kilo, [therefore you have] about

> 720 kilo meat walking around. You have to flip the grid, so the pigs do have to get somewhere else. But, where to? Chase [them] into the hallway? And then, you are the one to enter the shit; [that's] dirty, annoying and hard work. And, when [do they] break down? [Farmers] already know: [especially] at Christmas, Easter and over the weekend. Yes, but [you might say this resentment] is [a remnant] from the past of refuse conveyor belts: in the past they have worked more often with refuse conveyor belts, so you can say: the technology has very much improved, which is what the company [manufacturing the belts—bb&jg] says [when] the mechanics, who come to have a look in Sterksel at prototype 1 say: I don't get the fact that they put this in a pigsty.[8]

That this resentment was discovered only after years of development was because of the fact that the project initially was mainly driven by a technical idea rather than by the views and needs of market parties. Even though, at the time, the project leader did not fully appreciate these arguments, the applied researchers' arguments were taken seriously, as they were considered competent in their domain. Several technical solutions to circumvent these severe objections—like deepening the pit to allow for human access—were rejected for financial reasons.

More problems emerged in this phase, when the project team had to upscale from a pilot with 4x20 pigs to a real-life farm situation with 900 pigs. How could the spread of infectious diseases be prevented while the belts ran from section to section? And how could the balanced climate be maintained with the holes between sections, needed for the belts to run through? The pressure to go to the market in four years did not allow sufficient time for an intermediate design for compartments with eighty pigs, which the project leader considered necessary.

Reasons for leaving the belts further accumulated. It turned out that the firm responsible for the belts lacked the financial resources to provide the scaled-up version of Hercules. This was a serious problem, since the financing body EET did only pay for 40 percent of the costs of participating firms. When we interviewed the executive of this firm however, he stressed that the main reason was a lack of trust in the willingness of the rest of the project team to continue using the belts.[9]

Another argument, which was never made explicit in the project's documents, however, was the disbelief of a considerable part of the participating knowledge workers and firm representatives in the contribution of more straw in pig houses to animal welfare. Animal rights organizations had made strong pleas for straw. Straw would probably be part of future governmental regulation, and there was a strong conviction among people in the field that citizens wanted it too. However, according to some in the project team, there were

considerable scientific doubts about its "objective" contribution to animal welfare. Thus, one important benefit of the manure belts might be irrelevant.

As we discussed this theme with the head of the facilities hosting the pilot of Hercules, it emerged that the doubts about the use of straw were based on a mixture of arguments: scientific evidence, practical experience, and issues of human health. As the dialogue unfolded, the argument against straw interestingly transformed from an animal-focused argument to a human-focused argument and back:

> Do you believe in straw?
>
> . . . I do not believe in straw, no.
>
> No?
>
> No. No I do not believe in straw.
>
> It does not have to be put in at all?
>
> No, just as a diversion material, and diversion material for animals can be [provided for] in different ways.
>
> So it does not have to be straw per se.
>
> It's just like with kids, you can keep them busy in many different ways. Straw is a factor, because in the past it was used to keep up the temperature and everything associated with it, [and] it was used for nesting in the past. But a pig does not root in straw. A pig roots in the ground, so you better put a rooting trough in for those animals or something, than that those pigs [have to root] in straw. When there is manure in the straw, no pig will do any rooting in that straw. Yes, those are the faulty thoughts that pop up every once in a while.
>
> So is it true that the concessions [compared to the original idea of Hercules] are also based on arguments, because straw is [in fact] not really that important?
>
> No, but straw, . . . look [. . .] when you say at any given moment it should be friendly to the wellbeing of humans and animals and it comes up to a dust concentration in barns in which a human being, a normal human being, is not allowed to work in without proper equipment.
>
> Because of the straw?

> Because of the dust in the straw. And high dust concentrations are being measured. So this farmer will have to put on all this equipment to enter his barn, but the pigs are in there eating dust all day, [so, consider] what the disadvantages are of that straw.[10]

We are neither capable of nor interested in taking a position on straw's contribution to animal welfare. The point here is the way in which societal wishes and concerns are translated and scrutinized from the perspectives of those engaged in the Hercules project—including their anticipations of the views of "known others"—as well as on the basis of scientific arguments. This seems to be a reflection of the understanding of role divisions in the project. As one of our interviewees said in response to the question whether societal groups had to be involved in an early stage in a process like this:

> No, not yet. I think we should develop these things in relative peace, because you know their recent policy. And, so you try, is my belief, to—how should I phrase that—size up the power and truthfulness of such an argument, and [based on that—bb&jg] you prioritize.[11]

Finally, the *identity* of the engaged institutes reinforced this kind of arguments. On one hand, there were IMAG and Wageningen University, stressing their innovative role in the forefront, independent of what practitioners like farmers would think. These fundamental and strategic research institutes have a long-term orientation and are willing to take risks and to accept the failure of an experiment. They tend to orient themselves to society, the government, and the big companies, rather than the small firms and individual farmers. On the other hand, there were the more practically oriented institutes such as PV, deeply rooted in, and loyal to, the primary production sector. Historically founded by the farmers themselves, they have a much stronger loyalty toward them and still have a key role in demonstrating new and *proven* developments to them. Their *raison d'être* consists in helping these primary producers to survive in a changing world, and they tend to be much more careful with risky projects that may spoil their reputation. These two types of research institutes tend to compete with each other. The head of the Praktijkcentrum Sterksel, as well as a former head of PV claimed:

> …all new systems in use at pig farming at the moment, they basically come from us.[12]

> I think hands-on research these past few years has been most innovative on the subject of housing.[13]

This competitive attitude also had its effect on the proceedings of the first pilot at the PV. While an experiment under the responsibility of the IMAG, PV staff were supposed to do the work. The resulting difficulties were reported by the Hercules project leader:

> This is a stage in which technology should be developed, you know. So you have to take a shot across the bows. You say to yourself this is the best we can think up, let's make it that way. Yes, and you know as a technician, we will test it and we will see, so . . . we will have to adjust it at least three times before it runs somewhat smoothly. And one will put up with this, but another one will look at it and say I told you so, this does not work.
>
> And yes, in that stage already . . . I just know it, cooperation with Sterksel did not run smoothly, which was the case in several instances. That things were communicatively not passed on or not written down, or not done at all or done differently from the original thought of the researchers, which happened on a daily basis by the employers of Sterksel. Until it takes [for instance] up to four months before [. . .] a phone line is being connected or put through, well that kind of irritations.[14]

These different perceptions of the worth of an experiment, either as a risky but innovative undertaking or as a functional demonstration of a working concept, led to different appreciations of sensitive new techniques. While more fundamentally oriented researchers are used to tinkering around with a pilot while running, making *interim* improvements, practically oriented researchers have the tendency to judge the same experiment in terms of being useful or not. The belts had been lacking their sympathy from the start and therefore did not get the attention they might have needed. The same obstacles were met during the second pilot. For instance, practice-oriented knowledge workers appeared reluctant to engage in a demonstration project with 900 pigs using belts because technique under slatted floors, and especially manure belts, had a very bad image among farmers.

The Hard Work of Doing Reflexive Modernization

The above analysis of the fate of the belts in Hercules shows the hard work that has to be done if an innovative project does not merely build on current institutional differentiations, but needs to transcend them to be successful. As stated in the introduction, the duality of structure implies that it is possible to change structure by action, but also that structure may inhibit

this attempt for change at the same time. Therefore, reflexive modernization projects imply work on both the action as well as the structural side. While the Hercules team did a lot of work on action, it has—unconsciously—neglected structure.

The decision to leave the belts out of the concept can be plausibly interpreted in two different ways. For the steering committee, it was a hard, but perfectly legitimate decision to leave the belts out, if the Hercules concept would ever hit the market. These considerations entered the—initially technically focused—project through the emphasis on farmer involvement in the second stage of the program. Importantly, it could still bring the intended significant reductions in emissions and energy use as well as improvements in animal welfare. From this perspective, it must be stressed that Hercules still brought a significant innovation in pig farming, well in line with the EET program under which it had been launched, discarding risky options. As such, it can be considered successful as an attempt for ecological modernization.

At the same time, the decision can be interpreted as giving up much of the ambition of reflexive design, as a consequence of the resistance of the dominant regime (structure) against innovations that counteract this regime: what appear "technical" or "economic" risks were actually expressions of the existing regimes. From this perspective, the Hercules concept avoided rather than reflexively transcended these risks and became a highly sophisticated ecological optimization and continuation of current practices, instead of a systemic innovation reflexively reordering these practices at the husbandry level, as well as on the level of manure production and use. So, as to learn more on the problems and opportunities of reflexive design, we will analyze the project in more detail from this second perspective.

In a nutshell, what bothered the project from the latter perspective was that, first, it of course did encounter institutional difficulties typical for reflexive design, as we will argue in more detail below. Second, the project started with a long period of what Elmore (1985) has called *forward mapping*: designing an analytically sound solution to problems: Hercules started with a smart, original idea, and then set out to further develop it. Only much later a start was made with *backward mapping*, evaluating the solution in terms of feasibility and acceptability in the views of those involved. Backward mapping was not practiced until the project's embedment in P348, since the EET program, aiming the elaboration of technical solutions for a specific problem dimension, was at odds with the notion of backward mapping. At that stage, it was very hard to iterate between forward and backward mapping (cf. Elmore 1985; Grin and van de Graaf 1996), while too much time and other resources had already been invested. Moreover, such iteration, while

desirable from a P348 perspective, was at odds with the constraints implied by the EET program and further complicated by the "natural" tensions between the different knowledge institutes.

The Institutional Background of Some Crucial Difficulties

For a deeper understanding of the difficulties encountered, it is crucial to deconstruct them as contingent upon the existing regime—particularly on entrenched cultural traditions and functional differentiations within the animal production system and the associated roles, identities, and power relations built upon them—power relations that are the result from both the actual (allocative, relational) power over resources and people, as well as the dispositional power actors (actively) derive from external structures (Stones 2005, 73-74; Arts and van Tatenhove 2005, 346-51).

First, the hesitations to bring an integral system to the market and the problem of finding a lucrative market for the specialized fertilizer products were already traced back to *existing functional differentiations within and between agricultural production chains* in the preceding section. In structural terms, these meant that the firms participating in the Hercules project each represented a particular component of pig houses, like climate regulation, composting, belts, fertilizers, and energy. This by itself posed a threat to the integral character of the design. Participating firms anticipated that they would sell their share of the project best by itself; marketing them in conjunction with other components was surrounded by major uncertainties resulting from this task division. Therefore, each component was developed and judged as a unit in itself. This was reinforced by the cultural dimension of functional differentiation: the deeply rooted tradition of Dutch pig farmers to assemble their pig houses by eclectically combining a variety of components of different origin. These functional differentiations were matched by an equally sharp division of labor within the knowledge infrastructure, which was anchored in routines, standard ways of operating, research tools, cultural differences between institutes, and so on. This complicated the resolution of the consequent uncertainties even further.

Second, several problems may be attributed to uncertainties related to the fact that the knowledge infrastructure in which the project was embedded has privileged knowledge and design methods that fitted the regime of intensive agriculture (cf. Bos, Groot Koerkamp, Groenestein 2003). This partly explains that no "quick" answer could be found to such questions as the prevention of infectious diseases, as well as doubts concerning the benefits of straw.

Third, and somewhat more subtle, are the ways in which costs were considered (Integratiegroep Hercules 2001; Swinkels 2001) appears to have institutional roots in several respects. Costs of straw were calculated as costs for the composting and drying installations, rather than as contributions to animal welfare, which represents a "non-prizable" value in the market. Also, composting and drying were considered as separate installations that could be added later, rather than as a part of an integral design in the calculations, which implied some efficiency loss. Most fundamental, however, is the fact that even a relatively small difference in costs (5 eurocent per kilogram of meat produced) was seen as prohibitive, as an undeniable law of economics. We have two reasons to question this belief, which is true in a specific context only. First, the assumption that a higher prize should be avoided "at all costs" is essentially historically contingent: it reflects the fact that, after World War II, cost reduction has become a central objective of agricultural development (see section 2). This can be substantiated by the overriding trend in western countries that people spend considerably *more* on food than they did several decades ago, by eating more outdoors, buying more snacks, and increasingly relying on prepared food rather than primary products (Van Otterloo 2000). All these new food habits imply that consumers are apparently able and willing to pay a considerably higher price, paying for the added value.

In spite of this, the assumption of cost reduction as an overriding demand has, together with increasing specialization, gradually gained the status of a self-evident fact of life. It has been reified in the structure of the economic chain. Meat production is a buyers' market. Pig farmers are predominantly family enterprises, fiercely competing on a free market to sell their products to a relatively small group of processing industries and retailers (with allocative, relational power), reducing individual leverage. Within this market regime cost increases are treated multiplicatively rather than additively: the € 0,05 increase in primary product costs would become several tens of eurocents in the prize to be paid by end consumers. Within this regime, it was no less than logical that the costs of the Hercules concept were evaluated against those of traditional housing systems and that only lower or equal costs would be deemed acceptable.

A final, and maybe most subtle institutional effect is the reluctance of practice-oriented institutes to facilitate and relay the flow of knowledge from fundamental research institutes to practicing farmers. This may be traced back to their own perceived identity that ascribes a much more active and innovative role to practice-oriented research than is recognized in the dominant myth of knowledge generation prevailing in the intensive agriculture regime.

It has been emphasized in recent historical studies (Bieleman 2000; Priester 2000) that this myth overlooks a wide range of innovations that went the other way around. The resulting lack of recognition has irritated many involved. In addition, to the extent the myth was true, it was frequently seen as a shortcoming that more fundamentally oriented knowledge workers paid too little attention to practice in designing innovation.[15] It was in this field of tension that both types of knowledge workers developed—and defended—their identities. In this paradoxical way, researchers from the practice-oriented institute had become as much associated with the regime as institutes for strategic and fundamental research.

Unfortunately, these tensions also contributed to a juxtaposition of "feasibility" and "fundamental change," the first meaning "in line with current standards, routines and expectations," and the latter equated with "proposed by fundamental researchers." In one sentence making the practice-oriented institute primarily responsible for backward mapping introduced a strong risk inherent to reflexive design, which is that the existing regime would enter the project. The tension with the other institutes made it even harder to mitigate the consequences of this fact.

Lessons for Doing Reflexive Modernization

As stated in the introduction, doing reflexive modernization implies hard work. It requires transcending both the virtual as well as the actual structures (Stones 2005) of the existing sociotechnical regime one is aiming to change. Thus, even when participants may be convinced of the necessity to make changes in the actual structure to attain a type of progress that does take into account the risks and side effects associated with modernization processes, this conviction in itself is not enough to withstand the normalizing power of the existing regime. *Active protection* is needed to prevent a relapse into other types of modernization. *Strategic niche management* suggests the "niche" as the deliberately created locus that provides such protection. However, if we interpret this niche solely as an incubator, a protective environment for an innovation to grow, until it is strong enough to survive into the real and structurally unchanged world, it is not the type of protection we need for reflexive modernization. First, active protection should also imply what Roep, van der Ploeg, and Wiskerke (2003) call *effective reformism*: the capacity of the project and its niche to change structural aspects of the existing regime, to increase the life expectancy of the novelty once the shields are down. Second, what we learned from this project is that active protection

should not only be realized in the outside world, but should also be actively strived for in the consciousness of participating actors. Latour's idea of reflexive modernization as a master narrative shielding actors from the influence of the dominant regime might be a part of this, but more work is needed to prevent these participants from being forced to withdraw to actions that do not challenge structural features of the environment, they're necessarily part of. The following recommendations are meant to articulate exactly that work.

First, one should *envision the future regime in which the innovation is likely to flourish.* While the fact itself that the difficulties mentioned above were encountered should hardly come as a surprise, it is less obvious that it appeared so difficult to deal with them. To overcome these difficulties one should *contextualize, in a vision, the artifacts at the core of the proposed innovation*—here the manure belts and the fertilizer specialties to be produced—in a newly designed system that also includes *structural and cultural components*. For instance, to go beyond the cost problem one might have embedded the concept in a niche market and/or in a chain where the "laws of multiplication" of primary product costs would not apply. This essentially is what "sustainable visions" do in the STD method adopted in P348: they offer an orientation for collective action, as is also shown in different cases by, for instance, Weber (2003). More specifically, such visions help to redefine our anticipations and expectations by critically scrutinizing the underlying assumptions (Grin 2000). Or, in the wording of Dierkes, Hoffmann, and Marz (1996), they offer the "functional equivalent" of institutional guidance to reflexive innovations which, as we noted in section 1, are likely to run into the problem of "institutional void" (Hajer 2003).

Ironically, it was the construction of such visions that was hampered in Hercules (as well as in several other projects from P348, cf. Grin et al. 2004) by precisely those institutionally rooted problems that they were supposed to resolve. Two problems appear to stand out here. First, participating stakeholders as well as the more practice-oriented knowledge workers have a limited time horizon. As the PV representative in Hercules stated:

> "You [. . .] need to dare to draw a line and then I should say that, [. . .] you must not go on for another four years. Because then you will be investigating for twenty years and the market will be gone."[16]

Second, participants seem to have little reason to commit themselves to a vision so much removed from reality. Elsewhere (Grin et al. 2004) we have suggested that it is important to construct and present visions as (partial)

solutions to critical problems—like "reverse salients," (Hughes 1983) or "presumptive anomalies" (Constant 1980)—and to increase stakeholder's awareness of the urgency to their situation. Pig farmers could be made aware that continuation of existing practices would eventually be confronted with legislation, spatial problems and changing consumer preferences. Hercules could have been portrayed for instance as the future for pig farming on the countryside, but it was not, despite the fact that some interviewees formulated it as their personal motivation:

> [I do it] for the Dutch husbandry, countryside development, that type of things. Because, if you remove these sectors from the countryside, then an area like Brabant, but the Achterhoek as well, will turn into poverty, like it was, let's say, in the thirties."[17]

Second, one should *be explicit that the proposed reflexive changes "make possible what was not (conceivable) before."* Especially when used in relation to the former guideline, this may help in making it more worthwhile for participants to engage in constructing and realizing visions. The connection with critical problems may make them realize that they do have a stake here. The realization that, on a somewhat longer time horizon, things may become feasible, may both convince stakeholders of the sense in the vision and help persuade them to adopt this longer time horizon. Essentially, this recommendation is meant to initiate a dialectic between "thinking it is possible" and "making it possible."

Next, *reflexive design implies transformative action.* Structure and action are shaped by acting subjects. In a phrase of John Law (1992): structure is a verb. Future visions likely entail structural and cultural elements that differ from the present situation. Thus, reflexive design projects should orient their action toward a transformation of the existing regime as well. In the case of Hercules, this need for transformative action (Roep, van der Ploeg, and Wiskerke 2003) to transcend institutional differentiations is clear in a number of ways, as we pointed out in the previous section.

As a fourth recommendation, one should *make sure people with competences for such transformative action are available.* Working on the structural side and aiming for transformations of the existing regime implies the availability of competences for strategic action. Historically, this is what figures like Edison and Diesel did. We should stress here that, although such figures have been designated as "heterogeneous engineers" (Hughes 1983), a heroic "strong men" understanding of the term does no justice to the significant degree to which they actually integrated other players' problem

definitions and favorite solutions into the design of their vision (Dierkes 1996). It is more accurate to say that these central players appeared very capable of iterating between forward and backward through an interactive methodology (Grin, van de Graaf, and Hoppe 1997) by synthesizing other players' views. They have to work on the interface between the project and its complex environment, of which participants will be unavoidably part of as well. An important competence is therefore the ability to align their roles in those contexts to their role in the project. To do this, Grin and Weterings (2005) suggest that such "transition champions" have knowledge of the interpretive schemas of other actors in their context, their power and capacities within these contexts, and the ways they interpret and act upon the normative expectations and principles implied by their position. Other competences for transformative action include the ability to connect future visions to short-term projects in a compelling and convincing way; the ability to identify and take adequate counter measures to normalizing tendencies from within the project and its surrounding structure; and the ability to enroll public and private actors in such a way that the project's goals can count on sufficient legitimacy in its environment (see below).

While reflexive design projects generally tend to be local, their success and potential transformative effect will be strongly dependent on global conditions. *Government can play an important role, by orienting its regulation and facilitation unambiguously toward reflexive design.* In a case like ours, where a long-standing existing regime "stands in the way," there is—on one hand—a positive role for government in offering a forum for reflexive design. It can provide sticks and carrots that may act as critical levers for change; it may help to create the envisioned sociotechnological system (including elements to satisfy stakeholders' desires, expressed through backward mapping); stimulate the further development of nonestablished knowledge bases; and so on. It may further adapt or create physical infrastructure, help to bridge diverse practices that may reverse each other, and so on.

On the other hand, government should be more aware of its potential negative role inhibiting reflexive design. Our case suggests that governmental facilitation and regulation was too ambiguous. First, government did little to stimulate the project team to balance the industry-oriented innovation attitude of the EET program with the multi-actor problem-solving oriented approach characteristic for P348. It seems that the notion of "governmental retreat" has pushed aside the possibility of careful and fine-tuned intervention in various practices so as to realize governmental ambitions. The choice between one or the other was put to the project team. Combined with a natural inclination to go for quick results and with the fact that the contact with

practitioners went through practice-oriented researchers with little affinity with fundamental innovations, this made the project much less reflexive.

Secondly, the Dutch government did not provide a clear regulatory framework, thus hampering the project. For instance, the Hercules concept allowed for 60 percent of the floor being solid. The benefit of this for the concept itself was that the belts running under the slatted part did not have to be very large. However, as time lapsed, it became clear that governmental regulations would go for a minimum of 40 percent solid floor. Hercules would then of course be the "best boy" with 20 percent more, but it would also turn it into a competitive disadvantage in comparison with others, since farmers like to maximize the slatted surface, to minimize cleaning efforts.

This call for a more unambiguous role of government in stimulating reflexive design processes is not a plea for a return to a classic statist view on governance. On the contrary: government should create the room for transformative action to be maneuvered by others. The global directions (in *plural*) for this transformative action should however be perfectly clear and legitimized democratically. In our case, the project team and steering committee lacked the substantial support of government for their implicit vision on the desired future structure of agriculture, in which organic manure products replace artificial fertilizers. This *could* have been one of the global directions toward sustainability, which the state could provide and legitimize. Without, however, the project team had a very tough job convincing others to break with their current practices.

Concluding Remarks

As stated in the introduction, reflexive modernization can be seen both as a description of practice as well as a master-narrative, prescribing or—better—inspiring to look differently at the problems of modernization. We think this dual nature is not a sign of theoretical weakness, but rather an apt expression of the phenomenon itself: in dealing with the side effects of first modernization, people are confronted with and become aware of embedded mechanisms, practices, and institutional rules that were hitherto unquestioned. That is the descriptive half. But whether they are able to overcome these difficulties depends on their ability to position themselves within the (prescriptive) narrative, and act accordingly. Reflexive design as a methodology tries to supply the instruments for that—some of which we outlined above—and describes the necessary institutional conditions to facilitate this. The master-narrative of reflexive modernization supplies actors with a

meta-vision, which is a necessity in sustaining them to strive for the yet impossible.

The Hercules project is in no way presented as *best practice* in reflexive design. It is, however, a good example of a project *experiencing the challenge* of reflexive modernization, as it tried to deal with several undesirable side effects of first modernization at the same time, while also questioning some fundamentally engrained functional differentiations from the very beginning, like that between product and waste, or animal and crop production. With the introduction of P348 as a second source of financing and the introduction of elements of STD and ITA in its methodology, the Hercules project also acquired the *intention* for a reflexive approach, but it was too ambiguous, and it came too late. The then understandable focus on practical feasibility of the concept within a few years caused a disregard for a long-term road map derived from a future vision, while judgments of outsiders like farmers were allowed to have too little effect on the project. Thus, Hercules can be seen as a project of reflexive modernization that was pushed back into a more regular project of ecological modernization by the existing regime, because the project itself did not fully realize what the consequences of this position were for their efforts, and because it lacked the institutional support from the government to create room for reflexive maneuver.

This is not meant to suggest that ecological modernization as such is inferior to reflexive modernization. They may coexist in reality, applied to different situations. Reflexive modernization, however, cannot be avoided if one has a vision of a desirable situation that implies profound structural changes. Or, if one wishes to change the course of the river—as Hercules did so long ago—instead of merely adapting its flow.

Notes

1. More precisely, larger societal transitions comprise, and emerge from, system innovations (Re-modernization of these systems) in related domains.

2. Bram Bos has been a methodical adviser to projects like this since February 2002, and was asked by the project leader to evaluate the project; John Grin has been director and co-teacher of a methodical course for the project (and similar projects) team between September 1999 and the summer of 2001. The interviews were conducted by Bram Bos during the spring and summer of 2002. Interviews were semi-structured, recorded on tape, and worked out *verbatim*. Eleven interviewees were held with a representative selection of people from the participating research institutes and firms, and the steering committee. Although only we may be held responsible for the following analysis and its conclusions, we owe a lot to discussions with Dr. Peter Groot Koerkamp, project leader since early 2000, and other members of the project team as well as with Dr. Sierk Spoelstra, program director of P348 (see below).

3. IMAG, part of the DLO organization for agricultural research that later merged with Wageningen University into Wageningen UR.

4. In the EET program, sustainability was largely seen as a problem of ecology and economy.

5. Interview project leader of Hercules, August 20, 2003.

6. Peter Groot Koerkamp, personal communication, 2003.

7. Minutes steering committee, January 31, 2001.

8. Interview former head of practice-oriented research institute PV, May 30, 2002.

9. Interview director and marketing employee of firm producing belts, June 28, 2002.

10. Interview head of the facilities in Sterksel hosting the Hercules prototype, June 13, 2002.

11. Interview former head of practice oriented research institute PV, May 30, 2002.

12. Interview head of the facilities in Sterksel hosting the Hercules prototype, June 13, 2002.

13. Interview former head of practice oriented research institute PV, May 30, 2002.

14. Interview project leader of Hercules, August 20, 2003.

15. Illustrative here is the fact that three years after the end of the pilot with the belts in Sterksel, it turned out that the Praktijkcentrum had had much more technical troubles with the belts than they had bothered to register (Peter Groot Koerkamp, 2003, personal communication).

16. Interview representative of practice-oriented research institute, June 3, 2002.

17. Interview former head of practice oriented research institute, May 30, 2002. It is worthwhile noting that the policy of reconstructing the countryside (*Reconstructie*) of the Dutch government, another policy response to the 1997 CSF crisis seems to create an unintended market niche for more expensive systems like Hercules that give the opportunity to replace rather than relocate existing farms (Peter Groot Koerkamp 2003, personal communication).

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Bram Bos completed his PhD in 2004 at the Vrije Universiteit, Amsterdam with a thesis on the role of living organisms in technological systems. Since 2002, he works as a postdoctoral researcher at the University of Amsterdam, as well as a methodical adviser in several interdisciplinary innovation projects for sustainable animal husbandry at the Animal Sciences Group, Wageningen UR. His research interests lie in the field of technology studies, philosophy of technology, and policy studies on technological innovation processes.

John Grin is a professor in policy science at the Department of Political Science, University of Amsterdam, and scientific director of the Amsterdam School for Social science Research (ASSR). He obtained his PhD in 1990 at the Vrije Universiteit (VU), Amsterdam, with a thesis on defense technology assessment. After having worked on the same theme at VU and Princeton University, he joined the Department of Political Science in 1992. His research focuses on designing and instigating sociotechnological innovation, in particular in the areas of sustainable development and increasingly also on health care. Grin is director of a postgraduate course on methods for system innovation and a co-director (for governance studies) of Dutch Knowledge Network on System Innovations and Transitions (KSI), comprising ten universities and a Large Technological Institute (LTI).