Insolvent

How to Reorient Computing for Just Sustainability

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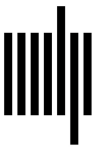

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CRITICAL REQUIREMENTS PRACTICE

A critical technical practice will . . . require a split identity—one foot planted in the craft work of design and the other foot planted in the reflexive work of critique. . . . This strangeness will not always be comfortable, but it will be productive nonetheless, both in the esoteric terms of the technical field itself and in the exoteric terms by which we ultimately evaluate a technical field's contribution to society.

—Agre (1997b)

If I ask you to design a new sustainable digital payment system, where do you start? Which questions do you have?

You might ask about existing infrastructure and systems (context), about who wants to make and accept payments (users), for what and how much and when (scenarios), or where and under which conditions (interfacing systems). You will have questions about existing standards (constraints). You will ask to speak to the users and other operators of this future payment system to identify what they want to achieve by using the system (stakeholders and goals). You will use these insights to figure out what the system has to do (functions) and how it should behave (qualities). And you will hopefully consider the direct and indirect effects of the system, including its environmental cost (sustainability debt). You may create mock-ups and prototypes to elicit reactions from stakeholders. The conceptual space you are traversing is inhabited by multiple fields and their frameworks,

which have grown up in different regions. From Design Land, the UX clan and the design methods family send their regards. From Engineering Land, we welcome requirements engineering and the engineering methods family.

I positioned requirements as a "key to sustainability" in chapter 1 because requirements activities reconcile the social with the technical. In just sustainability design (JSD), those activities reconcile the social, the technical, and the environmental: We move between what Goguen (1992; 1994; 1996) called the "wet" world of living experience, characterized by its situated, emergent, embodied, indeterminate, contingent, ambiguous, and open-ended nature, and the "dry" world of abstract models. Ideally, we make each legible to the other. The term *requirements* carries three meanings: First, it can refer to stakeholder needs and aspirations; second, to *statements about* stakeholder needs and aspirations, and third, requirements are understood as the web of concepts that are needed to reconcile the social and technical when making choices in systems design. In this latter interpretation, requirements encompass and connect stakeholders, their concerns and goals, scenarios of system use and operations, as well as the features and qualities expected of a system under development and the constraints it must adhere to. It is the broad understanding in the third sense that is captured here and represented in table 10.1.[1]

Requirements thus provide the frame of reasoning that ultimately justifies technical design decisions by reference to the social world. To play a meaningful role in JSD, requirements engineering (RE) cannot pretend to be neutral. It is not hard to see that the shift advocated in this book challenges existing social arrangements, values, and power relationships. No engineering or design method or tool can on its own change these power relationships or magically establish ideal speech situations in which all stakeholders are given equal footing. But if we agree that the practice of RE is political, and that the margin of maneuver available to RE professionals in systems design is shaped by current frameworks and ways of thinking, then the question arises: How do we reorient RE in practice? What could a *critical technical practice* for RE look like? How could it widen the margin of maneuver and carve out a space for enacting social change in systems design? These are the questions addressed in this chapter.

The field's name is unfortunate. Requirements are not so much engineered as they are constructed, elicited, developed, and negotiated (Alexander and

Beus-Dukic 2009, 7–15; Nuseibeh and Easterbrook 2000). They belong to the "discursive" sphere of systems design more than to the material structures created by it. But the naming reflects that the field's preferred approach to reconciling social and technical issues is to apply systematic, measurable techniques to model and specify requirements. This chapter will take a deep look into the relationship between RE's "dry" frameworks and the implications just sustainability concerns raise in the "wet" world of human experience.

> **requirements engineering**, n.: the social practice of turning wet, interesting issues such as human values, politics and moral decisions into dry, complicated diagrams (models) that create the illusion that the work to be done is solidly understood.

To address sustainability, requirements activities must undergo a paradigm shift, as illustrated in table 10.1. Key tasks are listed in logical sequence on the left. Concerns of effectiveness and efficiency dominate current practice. JSD requires a shift, articulated on the right. These activities do not only take place when they are explicitly attended to through formal models and explicit methods. The conceptual linkage between these steps remains relevant when we leave the RE worldview. Any systems design effort will undergo almost each step listed in table 10.1, whether explicitly or implicitly. In many cases, these steps remain silent and undocumented. For example, agile projects typically will not conceptually separate the user stories that describe prospective system use from the described system's scope, features, and qualities. In other cases, these aspects are documented in excruciating detail. Regardless, they form a path-dependent set of choices that systems design passes through like gates in a maze. In any given project, the series of actual choices will rarely happen linearly according to their dependencies. But choices listed earlier in the table cause ripple effects through subsequent decisions. For example, the scoping of a project influences which stakeholders should be involved, which in turn shapes what voices will have a seat at the table when success criteria are determined.

Accounting for asymmetric vulnerability in just sustainability has profound implications on how we conduct these tasks. For example, it

demands a shift in how we identify stakeholders, classify them, and incorporate their views. Current practice often involves a stakeholder influence matrix that maps stakeholders on two dimensions: influence over the project and interest in the project. This is often used to ensure that those with the most power remain supportive of the project. JSD will at least replace this with a matrix that prioritizes not those involved but those affected: by replacing the interest axis with an axis describing the expected impact of the system on their well-being, whether or not they are aware of it. This stakeholder map should then be used to prioritize those with the least influence who are most affected throughout the project stages, including all tasks listed in table 10.1.

It also shifts how we identify and account for risks. While current risk management practice often prioritizes the success of the project and its timely completion, JSD risk assessment may prioritize the identification of sustainability debt and the risk the project poses to its future environment, using tools such as the sustainability awareness framework (Duboc, et al. 2020) and long-term scenarios (Nathan et al. 2008) to identify systemic effects. When a project identifies significant risks of externalized sustainability debt but aims to proceed nevertheless, it ought to have an ethically sound justification, and ideally, that justification can be audited.

These kinds of concrete actions, however, can only take place successfully when accompanied by, and based on, more profound reorientations. For example, the shift in stakeholder matrix is easier said than done: those with influence may not exactly approve of it. The shift in risk assessment similarly is difficult to imagine in an organizational context driven by quarterly profits and shareholder returns unless the legal environment mandates it. And even then, we must pay attention to the politics of the process itself and examine how these politics shape it. That is the focus of this chapter.

Whether you formalize or not, when you design, you work out requirements. But reconciling the social and the technical in requirements activities should not simply mean performing trade-off analysis in a lone expert role to resolve any discrepancy. That would be an impoverished and unrealistic approach. Instead, good requirements work makes social concerns legible for the technical design sphere and makes technical features legible for the social design sphere. RE *as a discipline*, however,

Table 10.1 Systems design activities that reconcile technical and social issues (adapted from Becker et al. 2016)

Task	Standard current practice	Focus of a future sustainability design practice
Determine project objectives, scope, system purposes, and boundaries	Focus on the immediate business need and key system features. Don't question the project's or system's purpose.	Emphasize how the project affects sustainability in all dimensions. Strive to advance sustainability in multiple dimensions simultaneously. Experiment with different system boundaries to understand the changes' impacts.
Identify external constraints	Minimize constraints imposed by the direct environment of the system and its technical interfaces but include legal, safety, security, technical, and resources.	View constraints in each dimension as opportunities for design. Look for constraints from additional sources, starting with company corporate-social-responsibility policies, legislation, and sustainability standards.
Identify stakeholders	Minimize the number of stakeholders involved, and focus on those who have influence. Focus on internal stakeholders, and exclude unreachable stakeholders.	Maximize stakeholder involvement in an inclusive perspective integrating external stakeholders and involving those who are affected. Assign a dedicated role to be responsible for sustainability. Introduce surrogates to represent outside stakeholder interests.
Define success criteria	Focus on the financial bottom line at project completion. Measure the business outcome and financial return on investment.	Focus on advancing all dimensions of sustainability simultaneously, and take into account that most effects will occur after project completion.
Elicit requirements	Focus on the features and immediate outcomes the stakeholders want.	Help the stakeholders understand the system's enabling effects. Forecast potential structural impact (see figure 1.2).

(continued)

Table 10.1 (Continued)

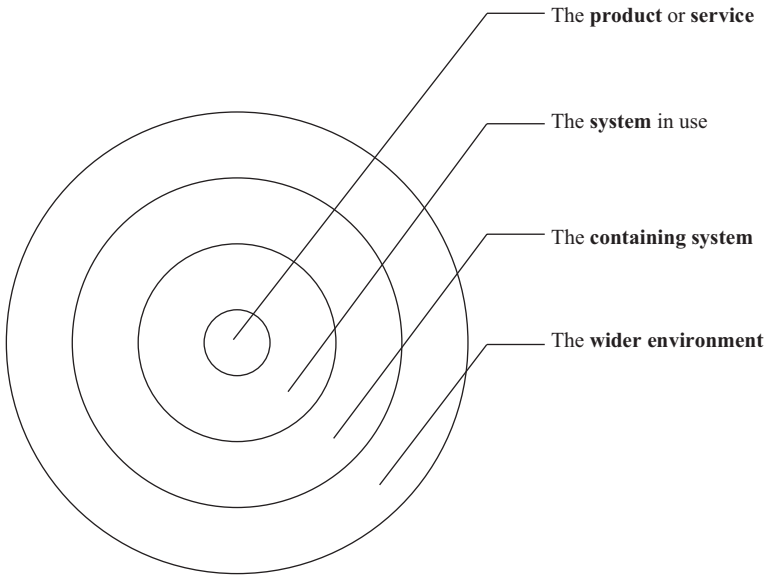
Task	Standard current practice	Focus of a future sustainability design practice
Identify risks	Identify risks that threaten timely project completion within budget.	Include the effects on the system's wider environment. Include enabling and structural effects and risks that can develop over time.
Analyze tradeoffs	View tradeoff analysis as a question of prioritizing and selecting; let the influential stakeholders decide.	Strive to transform sustainability tradeoffs into mutually beneficial situations. Ensure that a wider range of stakeholders discuss sustainability tradeoffs. Beware marginalization.
Decide to go forward or not	Base the decision on feasibility, financial costs and benefits, and risk exposure to project participants—that is, internal stakeholders.	The decision is based on a consideration of positive and negative effects in all five dimensions on internal and external stakeholders. The evaluation is made auditable to show to external audiences how it considered sustainability indicators and enabling effects.
Validate requirements	Let key stakeholders verify that their interests are captured.	Ensure broad community involvement focused on understanding systemic effects.
Complete project	Verify whether success criteria are met on completion, then focus on maintenance and evolution.	Evaluate the effects in all five dimensions for a certain time after completion. Align with the expected timescale of effects.

has grown to take a certain approach to the task of reconciling the two spheres it connects, an approach heavily influenced by *engineering* and by the myths of computing. Understood *as a science* (Akkermans and Gordijn 2006), RE applies natural and social scientific methods to building requirements. While the field has never lost sight of the social context of technology (Yu 2011; Jarke et al. 2011), requirements in this worldview are the object of an applied scientific enterprise and the products of engineering activity. Its dominant frameworks are built on rationalist worldviews that assume differences in value positions can be reduced to common denominators and empirically adjudicated on the basis of universal reasoning

frameworks. This entails the operationalism that comes with such an enterprise; it entails a focus on valuing precision, completeness, efficiency, quantification, and formality, reflected in its literature, textbooks, and standards; and it delineates the boundaries of what will be accepted into the enterprise as valid (scientific) knowledge.

Hence, the approach in RE to bridge the gap between the social and the technical has been to develop sophisticated conceptual models and practical methods of applying them in systems design situations. There are models, diagrams, and standards for every activity listed in table 10.1 and every imaginable relationship between the conceptual entities they relate to. I will briefly discuss some of the less formal approaches because they are more commonly encountered in practice and because their simplicity allows us to examine here how they are political.

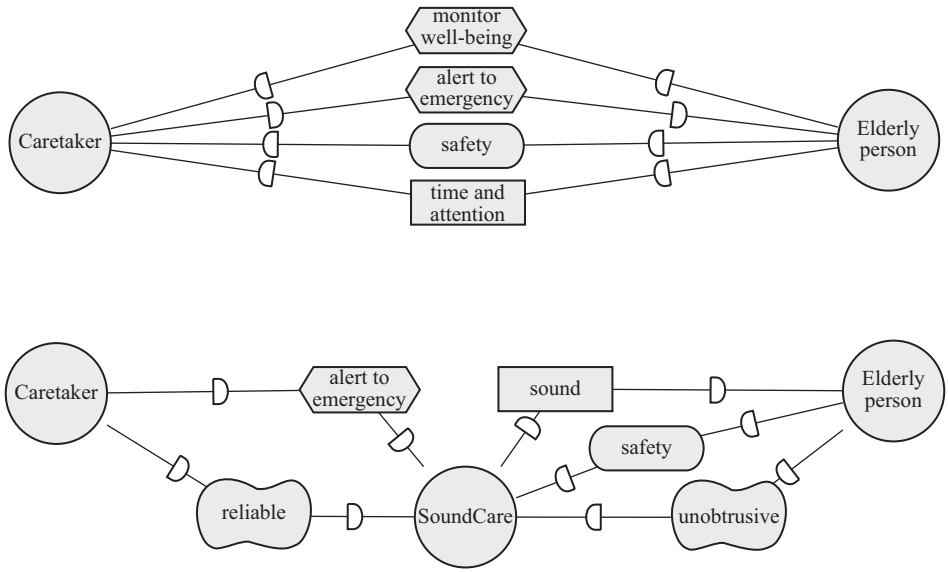
In early scoping stages, it is common to present an *onion model* in which stakeholders are located in concentric circles around a center occupied by the product or service to be designed. The basic structure of these diagrams is shown in figure 10.1. Those stakeholders who use the system directly are explicitly centered while those who are affected in distant ways are placed



10.1 The basic shape of product-centric stakeholder onion models.

at the margins. In some versions, the project team gets placed in an overlapping circle close to the center of the diagram. Drawing from information systems and management research and industry practice, the field has developed sophisticated taxonomies of stakeholders (Alexander 2005), techniques for eliciting and representing their views (Zowghi and Coulin 2005), and modeling approaches to connect this social sphere to proposed technical elements. For example, the i* modeling language (Yu 2011) represents social actors and technical components as interdependent entities linked by the way they enable each other to perform tasks, obtain resources, and achieve goals. This can be very useful to illustrate and analyze how introducing technical components changes the relationships between people and software systems.

Figure 10.2 provides a crude model of an elderly living scenario. The left depicts two stakeholders (shown as circles) and directional dependencies. For example, the elderly person is dependent on the caretaker to monitor their well-being (a task), for their safety (a goal), and for their time and attention (a resource). The caretaker is dependent on the elderly



10.2 Two simplified i* diagrams show actors in an elderly living scenario before and after technology is introduced.

person to alert them to an emergency (a task). These dependencies are altered significantly when a sensor system called *SoundCare* is introduced that detects accidents to alert the caretaker to a possible emergency. The SoundCare agent in the diagram on the bottom has an intermediary responsibility. People's dependency relationships change, and it appears that some of their interdependencies are rerouted through the product. The diagram also shows how people depend on technology to have certain qualities (reliability, unobtrusiveness). Social modeling provides a vocabulary to make these dependencies visible to facilitate reasoning processes and design decisions. But we should be mindful that knowing a vocabulary does not automatically bestow upon us an omniscient ability to represent reality:

> **goal modeling**: the illusion that everything that matters can be represented as instrumental achievement to be met; the delusion that anything that can not be represented as instrumental achievement to be met cannot possibly matter. Both are common in requirements engineering.

WHY REORIENT RE?

By deciding who to involve as stakeholders, how to elicit their views, how to consider these in design choices, and how to define success criteria, RE frames the scope of design and establishes the conditions for successful development. It is no surprise that the field is expected to address social and ethical concerns. The methods and techniques of RE are not programs, as we know, contrary to the myth of rational decisions. But they do structure social relationships and the meaning of work, and in doing so, they exert power. For example, formalized review meetings act as rituals that "maintain the appearance of rationality" (Rowlands and Kautz 2020, 18). We need to pay attention to the values and politics embedded in such models and methods. The professionals who practice RE engage stakeholders, facilitate and construct a shared understanding of what systems development should achieve, and represent that understanding in requirements specifications. They are thus often seen as translators, mediators, facilitators, or moderators between and among different discourses. Their

position at these intersections affords them a unique opportunity to raise concerns of just sustainability, so they carry a moral responsibility.

RE today recognizes two paths to bridge the gap between the social and the technical. First, social modeling frameworks represent social actors and their motivations and intentions and document how they motivate and otherwise relate to designed artifacts and their qualities. Through these models, RE has addressed *domain complexity* exceedingly well. It is important to realize that approaches such as the i* social modeling language address social complexity only *as domain complexity*. They do not address the social complexity of a project's situation characterized by conflicting worldviews, unevenly distributed power, false consensus, or coercion (see chapter 8). Much less has been done to address such social complexity, and in particular, the uneven power relations between the different stakeholders involved in RE activities and affected by them (Milne and Maiden 2012).[2] Conventional RE simply has little to say about the politics of its models and methods and nothing about their formal biases. It considers itself a neutral technology and its process, a rational process.

Second, to address the well-known fact that many different problem formulations and system purposes are conceivable at the start of a project, experts often suggest the use of what they describe as "soft" approaches such as soft systems methodology (SSM). Techniques from these frameworks are suggested as tools to establish what the project purpose should be in ill-defined problem situations. However, a close look reveals that RE frameworks and methodologies themselves remain grounded in the scientific method, the view of engineering as its application, and a hard systems-epistemology.[3] As a result, they lack the vocabulary, concepts, and methods to address social questions of politics, morality, ethics, values, discourse, and belief systems. Instead, they treat problems and systems as given objects.

When practitioners move between the rich human and social worlds and the formalized technical models and methods used in RE, then, the expressive adequacy of technical models and the inadequacy of social theory are not balanced. Even if practitioners apply SSM more fully, as some do, SSM does not address the marginalization that inevitably arises out of power dynamics. As a result, those practitioners who recognize value tensions and conflicts can feel rather helpless. And it appears that their numbers are increasing as awareness of the role of IT in sustainability and justice

rises. Ultimately, many requirements professionals are aware that they carry responsibility and have the opportunity to influence the outcomes of systems design, that this influence is not neutral, and that their will to change stands in conflict with existing power structures that define their jobs (Chitchyan et al. 2016). But RE practice offers little guidance in recognizing values, negotiating value tensions, and in particular, dealing with value conflicts under the surface (Thew and Sutcliffe 2017).

In other words, the myths of computing *depoliticize* RE: they make it look as if a neutral, objective method was used to discover and document preexisting requirements fairly. The outcome has the illusion of technical rationality and presents itself as a neutral object. Requirements become reified; the statement takes on the appearance of a fact. In this context, even if RE professionals approach their task with the best intentions,

> how are they supposed to justify their work, their design decisions, and their actions if it is not considered feasible to estimate or predict possible effects over time and in many contexts; if they have no foundational education in social sciences, policy, or ethics; if they are embedded in industry projects with tight timelines, expectations of profit, and dispersed networks of potential stakeholders? (Duboc, McCord, et al. 2020, 18)

RE research and practice have tackled sustainability by introducing frameworks that allow the integrated consideration of direct, indirect, and systemic effects understood through environmental, social, and individual lenses in addition to the prevailing technical and economic views. Frameworks such as SusAF (see figure 1.2) continue the tradition of developing conceptual models to represent domain complexity and are now slowly taken up in industry projects.

These are important conceptual advances, but of the challenges of JSD, this framework addresses only domain complexity, not social complexity. It addresses an information problem: What is this system's sustainability debt? It does not provide an analytical framework to examine the question causally. It provides a framework to *represent* answers, but the designers need to find them elsewhere. This is why it is presented as an elicitation and awareness tool (Leticia Duboc, Penzenstadler, et al. 2020). That leaves open the substantive question of sustainability *analysis*. To begin to address it, we need to consider what happens when we interpret the outcomes of such analysis. The reorienting lens shows us: The answer to 'what is the system's

sustainability debt' is predicated on how problems are framed and how system boundaries occlude their assumptions. These will always require critical examination (see chapter 8). The decisions made on the basis of the answers are not 'computed,' because they are human judgments (see chapter 7). Any consequences of these decisions carry value implications that are again in need of justification (see chapter 6). And to conduct this analysis ethically in a context of asymmetric vulnerability and moral corruption, we need the help of our critical friends (see chapter 5). In other words, we need to address the challenge of social complexity before we can hope to address the challenge of domain complexity.

THE ROOTS OF RE

Because of its conceptual orientation, conventional RE as characterized on the left side of table 10.1 cannot address the central challenges of JSD. Conceptually, it is simply too firmly grounded in a rationalist worldview. There is a historical explanation for this too: the roots of RE lie in the tradition of corporate engineering. The positioning of the requirements role within the organizational context of systems development projects is bound to serve those who are involved and, in particular, those who pay for the requirements activities:

> Stakeholders include anyone with an interest in, or an effect on, the outcome of the product. The owner is the most obvious stakeholder, but there are others. For example, the intended users of the product are stakeholders. . . . Potentially dozens of stakeholders exist for any project. Remember that you are trying to establish the optimal value for the owner. (Robertson and Robertson 2012, 44)[4]

Even if placed in an ostensibly 'neutral' position, RE professionals[5] inevitably serve those who define their reference systems. This is not new: the subservience of engineers to industrial capital was at the heart of the job description when that job emerged over a century ago.

> From the outset . . . the engineer was at the service of capital, and not surprisingly, its laws were to him as natural as the laws of science. If some . . . drew a line between technology and capitalism, that distinction collapsed in the person of the engineer and in his work, engineering. . . . "the dollar," [a leader] told Purdue engineering students, "is the final term in every engineering equation." . . . The economic inspiration inherent in technical work, of course, did not altogether

rule out the possibility of conflict between the demands of technological superiority and of market expediency. When such conflict did arise, however, there was never any doubt about the outcome. [A leader's address to engineers] in 1896 had no trace of ambiguity: "The financial side of engineering is always the most important: . . . [the engineer] must always be subservient to those who represent the money invested in the enterprise." (Noble 1977, 34–35; see also 1984)

CRITICAL REQUIREMENTS ENGINEERING IN PRACTICE

If the myths of computing depoliticize RE, how can we restore an awareness that politics are always there? How can we invoke and apply the politics appropriate to the complexity of a project's situation and especially, the asymmetry of stakeholders? Agre proposed to develop leverage by working critically *within* the technical fields. He hoped to create a dialectic between constructive work and critical reflection. This would not be easy, and it takes time:

> Successfully spanning these borderlands . . . will require a historical understanding of the institutions and methods of the field, and . . . a praxis of daily work: forms of language, career strategies, and social networks that support the exploration of alternative work practices that will inevitably seem strange to insiders and outsiders alike. (Agre 1997b)

To develop a first version of a critical technical practice in RE, I brought RE into contact with critical systems heuristics (CSH). In discussing the project we conducted (first described in Duboc, McCord, et al. 2020), I focus on the first few activities of table 10.1, asking:

1. How can RE activities be augmented to uncover and negotiate implicit value positions?
2. How can RE critically interrogate the fact that RE professionals must always make selections and choices that are ultimately always political and partial, without becoming paralyzed?[6]

The SoundCare project described here focuses on a vulnerable population of elderly people living in their own homes. It addresses the long-established worry that fragile seniors are susceptible to accidents and may be unable to call for help. SoundCare brought networks of acoustic sensors to the rescue. A research group had developed algorithms capable of finely detecting acoustic events and was exploring a range of domains

in which they may be useful. The project received funding for technology transfer research with an industry partner. You may notice a whiff of solutionism: technology was searching for a suitable problem to solve.

The product proposal describes a wireless acoustic sensor network used to capture and analyze sounds in the homes of elderly people to detect sounds that indicate accidents or changes that a caretaker might follow up on. The project focused on early-stage requirements engineering. We structured it using action research.[7] Our challenge was to perform the activities of table 10.1 using the approach in the right-hand column, albeit in a context focused on the approach on the left. The idea was quite simple: We would combine standard RE practice with CSH by performing iterative cycles of RE practice combined with reflections and critique. We wanted to plant one foot in the craft work of RE and the other in constructive critique, balancing our steps with the help of our critical friend CSH. During each cycle, the "requirements engineer," Leticia, would (1) interact with stakeholders to create new RE artifacts and (2) use the CSH questions to update what CSH calls the *ideal map*. This is not a visual map but a set of tentative responses to the twelve questions represented in table 10.2, posed in the *ideal mode*, for example, "Who *ought to be* the beneficiary of SoundCare?" Ideal maps in CSH are and always remain tentative and incomplete. They are not treated as a checklist but as probes for continued exploration.

After these two artifacts were created or updated, Leticia reviewed them jointly with one or two research partners in a *critical friend* role. We distinguished two such friends: one was closely involved in each iteration and thus became part of the team; the other remained more distant to represent a more critical, even polemic attitude. While the former helped Leticia to navigate the conceptual space of CSH, populate the map, and reflect on the questions and answers, the latter probed into the map's entries, using them as starting points for questions.

CSH can be used in a range of modes with differing intent.

1. *Critically heuristic self-reflection* is a form of reflective practice. "What are the boundary judgements presupposed in what I believe or claim to be true or right? What is the normative content of these boundary judgements, as measured not only by their underpinning value assumptions but also by their live practical implications, i.e., the ways they might affect other people? Should I consider alternative boundary judgements, and what would be their

Table 10.2 CSH questions for designing a system S (adapted from Ulrich 1987, 279)

	Specific concerns (stakes)	**Social roles (stakeholders)**	**Key problems (issues)**
Sources of motivation	What is/ought to be the **purpose** of S?	Who is/ought to be the intended **beneficiary** of S?	What is/ought to be S's **measure of success or improvement**?
Sources of control	What **resources** (i.e., conditions of success) are/ought to be under the control of S's decision maker?	Who is/ought to be the **decision maker** in control of the conditions of success for S?	What conditions of success are/ ought to be outside the control of S's decision maker, i.e., in the **decision environment**?
Sources of knowledge	What are/ought to be considered relevant **expertise**, knowledge, and skills for S?	What **experts** are/ought to be providing the relevant knowledge and skills for S?	What are/ought to be the assurances of validity for relevant knowledge for S: i.e., what is its **guarantor**?
Sources of legitimation	What are/ought to be the opportunities for **emancipation**, for the interests of those negatively affected to have expression and freedom in the worldview of S?	Who is/ought to be the **witness** representing the interests of those negatively affected but not involved with S?	What space is/ ought to be available for reconciling different **worldviews** regarding S among those affected and involved?

normative content? What ought to be my boundary judgements so that I can justify them vis-à-vis those concerned?" (Ulrich 1998, 7)

2. *Critically heuristic deliberation* is a form of dialogue: "Why do our opinions or validity claims differ? What different boundary judgements make us see different 'facts' and 'values'? How does my position look if I adopt my partner's boundary judgements, and vice versa? Can we agree on differing boundary judgements, and if we cannot agree, can we at least understand and respect why we disagree?" (Ulrich 1998, 8)
3. The *polemical employment* of boundary critique, finally, supports a more confrontational debate: "How can I make visible to others the ways in which my opponent's propositions depend on boundary judgements that have not been declared openly but which are debatable? How can I argue against an opponent's allegation that I do not know enough to challenge [them]? How can I make a cogent argument even though I am not an expert and indeed may not be as knowledgeable as the opponent with respect to the issue at hand?" (Ulrich 1998, 8)

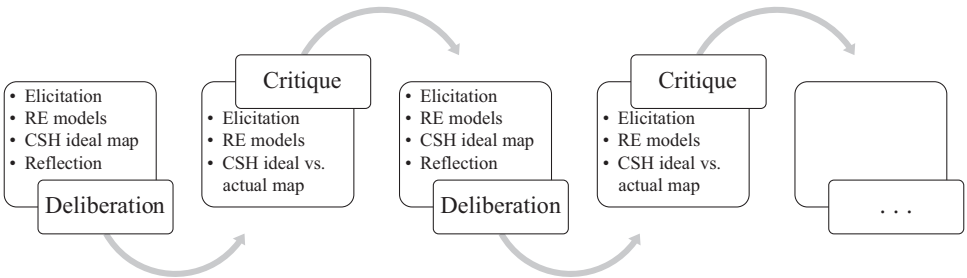
Over the project iterations, we used CSH in all three modes. Leticia, who was new to CSH, used it for self-reflection. The *deliberation* stage in figure 10.3 employed the dialogical form of critically heuristic deliberation. We alternated this with a *critique* stage, which shifted between deliberation and polemic. We designed this configuration to ease the difficult conversations we can have with critical friends, and it often led to the discovery of underlying assumptions, making visible the *reference system* on which the ideal map was built (see figure 5.1).

The project underwent some significant shifts that I will illustrate with a focus on the ideal maps, highlighting CSH question categories in *italics* and key levers that re-integrate politics into RE in **bold**.[8]

Ideal map 1 was created by Leticia and one of the critical friends as the latter walked the former through the CSH process. It contained Leticia's observations from her previous discussions with the SoundCare development team, third-sector organization, and the caretakers of elderly people. Among other things, the map identified the elderly as the main beneficiary with the stated *purpose* of increasing their independence and enabling them to stay in their homes longer. It also set the elderly person's "independence and well-being levels" and the "number of years living alone at home" as *measures of improvement*.

Reflection revealed, among other things, that this first map represented the **privileged views** of those developing the system. The team consulted the notes of previous conversations with stakeholders to reflect their needs more accurately.

Ideal map 2 was created after the consultation of the notes from previous meetings and interviews with stakeholders. The new map added the families as a *primary beneficiary* and the health-care system as *secondary beneficiaries*, extending the **boundaries** of the system. The *purpose* now included peace of mind for families. Ideal map 2 also reviewed the concept of well-being and independence, among other things.



10.3 Iterating construction and critical reflection.

Reflection on the validity of our *measurements of success* made the team reflect on the legitimacy of our situated knowledges and the necessity to introduce different types of knowledge, most importantly, elderly people or at least professionals with expertise relevant to the situations of elderly people. For Ulrich, relying on incomplete or dogmatic perspectives is a major **source of deception** and can be a false guarantor that harms our understanding of the situation and our system's design. Reflection also raised a number of questions, including: Is "years at home" a suitable measure of well-being? Should the purpose be to increase independence or rather self-determination? What if the elderly *cannot be* the decision makers? This last question in particular raises important issues of fairness in representing the concerns of those at risk of marginalization.

What I personally found most interesting at this stage is how CSH helped make something obvious: In contrast to the stated project purpose, the real purpose of the product could not possibly be to exclusively benefit the elderly themselves. An honest articulation of its purpose had to prioritize the caretakers' benefits. That the system was more for them than for the elderly became clear when examining how the argument for benefits was constructed and operationalized via measures of improvement. Following the trace, from one CSH category to the next, made it very explicit that little would change for the elderly themselves. This was not a function of one particular question, but the relationships between them. CSH made it impossible to ignore the discrepancy between the ideal responses and the actual requirements statements. The critical friend's questions reshaped the scoping and purpose of the project. They introduced different values, different facts, and different boundaries (see figure 6.2). The logical consequence was to take a closer look at how the elderly may be negatively affected and seek out expertise on that matter.

Ideal map 3 integrated the views of a social worker with those of a psychologist, both specialized in issues of the elderly. The interviews highlighted several concerns, including that the system did not increase independence but rather security (as it cannot meet their physical and emotional needs), and that the number of distress calls from the elderly were a **false guarantor of success**. We also learned about common behaviors, coping mechanisms, and the importance of a trusted person. This map included new measures of success (e.g., increased social support, reduced anxiety of the caretaker, earlier detection of dementia) and professional scales used in psychology and social care to measure the well-being of elderly people and their caretakers. This shift was a direct outcome of the reflection on the types of knowledge that could be considered legitimate sources

of evidence in the previous iteration. The map also included an extended list of decision makers and sources of knowledge.

Reflection raised doubts regarding the measurement of self-determination and early signs of dementia.

Ideal map 4 was developed after an interview with a practical philosopher who specialized in how technological projects affect ethics and privacy. We explored such questions as: How do you frame care and well-being? Can overreliance of families on this technology lead to a loss of "human touch" and thus reduce well-being rather than support it? Can the technology reduce the autonomy of the elderly person, who should have the right to decide when to get help? Will third parties be interested in these data? Each of these questions brings **power imbalance** and the **politics** of stakeholders to the forefront of RE activities. Finally, we recognized the importance of public debate on such technologies, and we identified techniques from practical philosophy for uncovering stakeholder ethics, morals, and values. The new map included autonomy as a *primary aim*, offered a better definition for self-determination, identified the general public as a *desired expert*, recognized institutions that want data as a commodity as *undesired experts*, and incorporated possible worldviews about being old, supporting the elderly, living the good life, and surveillance technology.

Reflection led us to recognize we had been more concerned with people's perceptions than security. We identified a knowledge gap on security and decided to interview a security expert.

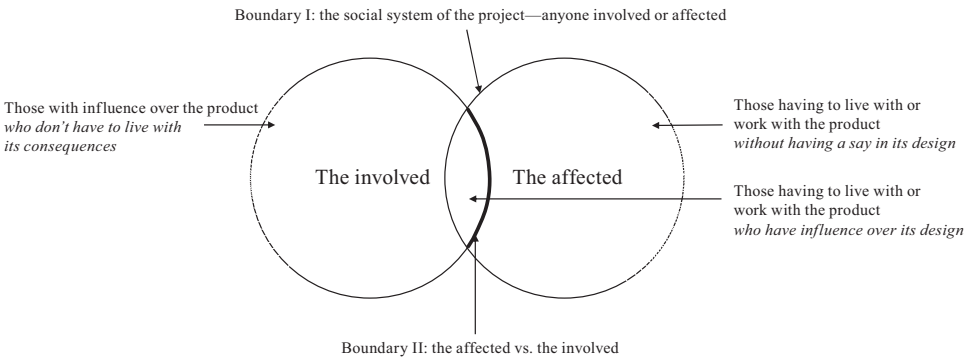
Several additional iterations followed (Duboc, McCord, et al. 2020). Each simultaneously shifted the boundaries of the system and made the underlying reference system visible. The project resulted in a requirements specification alongside reflections and template materials for the use of CSH in RE. But most importantly, the project enacted a *reoriented* requirements practice and showed that requirements work *can* be politically conscious. I will illustrate this in two effects of the critical friendship that stood out to me.

THE DILEMMA OF THE WITNESS

First, CSH put to the forefront the dilemma of the *witness category* illustrated in figure 10.4. Ultimately, only those living with SoundCare are in a position to legitimately approve the effects of the product's features and affordances on their lives. On that subject, they are the ultimate experts. Yet, it proved practically very difficult to involve them fully within the resource constraints of this project.

Experts such as social workers, psychologists, or neurologists speak for and on behalf those affected, but the *guarantor* for the legitimacy of their expertise ultimately rests on some form of authorization that lies outside their area of expertise. We may assume that the expert speaks as surrogate for the affected, but the surrogacy assumed by the experts is not innocent. Ultimately, there is no full substitute for participation. This points to the *sources of legitimation*. We were not initially in the position to empower at least some of those affected and move them from the right side to the center of figure 10.4. So what was the ethical thing to do: cancel our participation in this project or attempt to represent the interests of those affected but not involved? Similar to a classic study in critical systems thinking (CST) on boundary critique, we decided to cautiously proceed to the best of our abilities, engaging in continuous reflection on the boundaries of the views represented and the absent situated knowledges.[9] The team eventually succeeded in interviewing many more elderly people and caretakers. Despite the detailed attention to stakeholder models and the notion of *surrogacy*, conventional RE does not offer such systematic guidance to identify systemic marginalization. Nor does it offer the reflective capacity that CSH introduces.[10]

You might object that CSH did not discover anything new or surprising here. Other fields in computing have long demonstrated nuanced sensitivity to participation and marginalization in designing for *and with* vulnerable populations, drawing on other critical friends such as feminist STS and disability justice (Frauenberger, Good, and Keay-Bright 2011; Spiel



10.4 Stakeholder boundaries in systems design.

et al. 2019; Costanza-Chock 2020). From this perspective, it is obvious that those affected should be empowered to design. But that is precisely the point: CSH makes no claim to have the answers. Instead, it facilitated the emergence of the argument within RE and made it impossible to ignore it in a team with little prior expertise with participatory design. Less-than-ideal team composition is a frequent occurrence in RE practice. When we genuinely consider sustainability and justice in systems design, the implication of far-reaching, long-term concerns is that those affected will *never* be fully involved. CST made the argument for shifting participation, and it provides a framework to reflect on the inevitable limits to participation in relationship to the positionality of situated knowledge and the varying forms of participation.

THE SACRED AND THE PROFANE IN SYSTEMS DESIGN

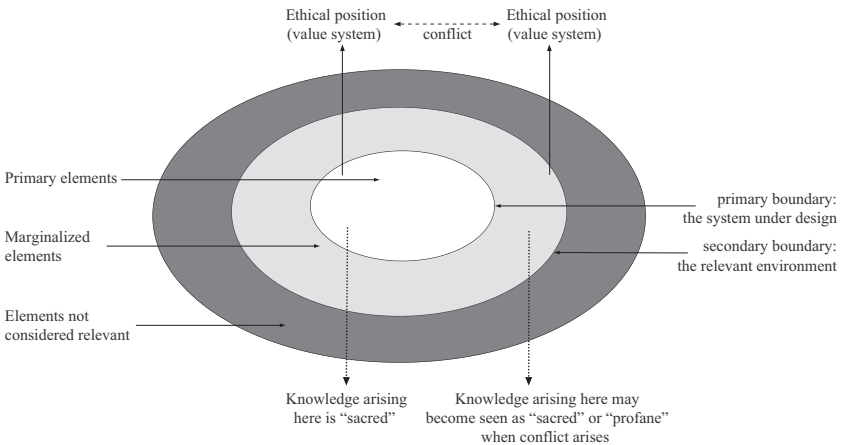
The SoundCare project also illustrated how CSH turns the tables on our expectations of where legitimate knowledge comes from. Stakeholders who are nominally participating, for example as interviewees, are not automatically decision makers in CSH terms: that is, they do not automatically shape boundary judgments. Instead, they are often merely treated as a "data source" for design: their knowledge is used by those who design (Palacin et al. 2020). CST practice involves close attention to what STS calls positionality and situated knowledge via what Midgley (2000) calls *second order boundary critique*. It examines the boundaries of the social system that generates knowledge claims and how these boundaries evolve over time. It offers a way to think through and reflect on the different degrees of validity afforded to varying situated knowledge claims arising from shifting boundaries. In other words, it provides a structure to examine positionality.

If models are the carpet under which we can find the values and politics that have become technological artifacts, what can we find under an onion model? Figure 10.5 illustrates the same type of boundaries that underpin so-called onion models (see figure 10.1). Let's discuss their politics, or what we may call their formal bias. For simplicity the diagram only shows two crucial boundaries that are always established: the boundary of the system to be designed and the boundary that includes those parts

of the environment that are considered relevant because they affect, or are affected by, design.

In the case of SoundCare, unless elderly people themselves *operate* the system, their claims and knowledges would be located not within the primary boundary but within the secondary, while technical and professional expertise are located in the primary boundary. Matters are further complicated by the presence of surrogate stakeholders such as elderly-appointed trusted decision makers and legally appointed guardians. When a conflict arises between two claims or value systems, it is often resolved by marginalizing one (Midgley, Munlo, and Brown 1998). And when claims about facts or values out of different spheres collide, they do not meet on equal footing. The views of this vulnerable population were therefore at risk of being dismissed by others who consider themselves to be properly trained, educated, and knowledgeable. In other words, their knowledge could easily be relegated to a profane, trivial status, while professional knowledge about RE, acoustic event detection, or elderly care may appear uncontestable.[11]

This happens in practice every day, whether we notice it or not. But when we probe the reference system of assumptions that justify and elevate some types of knowledges and marginalize others, the burden of proof shifts to the experts who need to justify not only that their claims



10.5 Marginalization and the sacred/profane (adapted from Midgley, Munlo, and Brown 1998).

are correct but, more importantly, that the expertise they use to justify their claims is legitimate. When it comes to evaluating whether their own knowledge is relevant and adequate, experts cannot rely solely on that knowledge itself to make the argument but need to rely also on boundary judgments. When it comes to justifying their reference system—the boundary conditions on which their application of knowledge is based—they are lay people like anyone else. In the face of the CSH questions, their knowledge is no longer sacred: "There are no experts in the systems approach" (Churchman 1979a, 232).[12] This decentering of codified knowledge is a crucial effect of CSH. It does not level the playing field altogether, of course, but constitutes a key step in reorienting RE for just sustainability.

CRITICALLY SYSTEMIC RE

The asymmetric vulnerability that characterizes the ethical question of just sustainability was mirrored, on a much smaller scale, within the microcosm of the SoundCare project. The project thus represents a central challenge to JSD: How can we justify the normative implications of systems design, as Werner Ulrich would frame it?

In the SoundCare project, CSH supported us in navigating the design space and counteracted the pull of the myths of computing. It made it easy to see:

1. **How problems are framings**: The repositioning of beneficiaries happened because the connected nature of categories in CSH's sources of motivation threw into sharp relief how success criteria were going to be operationalized and who would really stand to benefit. This made the problem frame appear explicit and contestable.
2. **How RE is political**: Once the framing of the original problem appeared in this new light, it also appeared decidedly political because it illustrated how alternative designs reconfigured the social relationships of those affected. I* is actually quite good at representing configurations of social relationships among stakeholders, but it will only enable a meaningful dialogue *about its politics* if it is used within a critically systemic framework such as the one presented here.

3. **How values become facts in RE**: The tensions that surfaced in the comparisons between ideal maps and actual maps, including what would appear in alternative i* diagrams, always connected statements of boundary, facts, and values. CSH made visible that a choice between different boundaries inevitably was a value-loaded choice that in turn created future facts.

By planting one foot in the craft work of RE and the other in the critically systemic work of CSH, we thus developed what I describe as a *critically systemic approach* to RE. The point here is not to argue that this approach was the best possible approach to conducting this kind of project. I would much rather defer to others better prepared to design for the elderly. Rather, the point is to illustrate how we can reorient RE to become critically appreciative and conscious of its political nature. In other words, CSH can help us thoughtfully reintroduce an awareness of politics into RE practice. CSH also offers concrete steps in design to what Sen (2009) describes as a "comparative approach" to justice: it is not aiming to define or design the "perfect" situation or system but aims to evaluate, compare, and improve the real situation in which design takes place.

In a retrospective interview about the role of CSH in SoundCare, Leticia brought up its role in supporting reflection, emancipation, and pluralism. She said: "What's nice about CSH is that it guides you into exploring these different aspects that I would probably not have asked about . . . CSH makes you aware of how your own views can shape the system." She thought in a standard RE process, "We would be the one taking all these inputs and then giving the privileged [those involved in the project] the task to reconcile them." In other words, the argument CSH makes for stakeholder emancipation shifted the modes of participation in a direction more consistent with participatory design and design justice. Leticia, however, considered the learning curve steep: reading the theoretical and philosophical work behind CSH, as she had attempted, proved difficult. Ulrich's and Reynold's case studies did not help to clarify how they worked with CSH. A crucial gap was simply that a critical technical practice, with one foot in technical craft and one in reflection, is still not part of mainstream computing education: "no one is being taught like this," she says, but "as you start developing the map, it becomes easier," and over time it can become

a central component of a critical, reflective practice. She continues to work and teach with CSH, and others have begun to do the same.

If values beget facts, then pulling on the thread of facts begets values. To some degree, we can unravel the carpet of modeling to marvel at its composition and structure. And the use of CSH very effectively questions every framing and makes visible its associated sources of motivation, control, knowledge, and legitimacy. On that basis, it is difficult for any framing to become reified. Using these categories also sidelines correctness and efficiency in favor of legitimacy.

Such reorientation changes the activities listed in table 10.1. Instead of focusing on the immediate business need(s) and key system features without questioning the system's purpose, we experimented with different system boundaries to understand the impacts change would have. The team counteracted the tendency to minimize the number of stakeholders (meant to increase efficiency and focus on those who have influence). Instead, we widened the field of view and reflected on issues of surrogacy and legitimacy. Table 10.3 maps some of these early RE concepts and models to the issues that are often overlooked; the CSH questions that bring these issues to the surface; and the CST concepts that shine a light on them. Note this is not a checklist. Whenever we probe into one question, we are led to the others, so the example questions are an illustration, not a prescription for a method.

The practical effect of this type of practice will always be constrained by the political realities of the design context, and much remains to be explored even within this limitation. For example, CSH raises the importance of *reconciling* viewpoints but leaves it open to those involved how to interpret the meaning of reconciliation and how to address it. Decentering codified expertise opens a space for a pluralist view but does not populate it. How do we design such a process to facilitate RE for the "pluriverse"? And how will this process work in a situation where sustainability is to be evaluated, for example if SoundCare gets further developed as a smart sensing service?

There are pathways to pursue to build on this critical technical practice for RE. First, we need to gain more concrete experience with the approach and with other approaches to attain a reoriented, politically conscious,

Table 10.3 Mapping critically systemic concepts to stakeholder-focused RE concepts and activities

RE concepts and models	Issues	Example CSH questions	Critically systemic heuristic concepts
Stakeholder categories are used to identify and classify relevant stakeholders	Is the distribution of benefits and harms fair and just? On whose account?	Who is/ought to be the intended beneficiary?	Boundary I Boundary II Sources of motivation
Stakeholder viewpoints are used to represent divergent interests and perspectives	How are conflicting perspectives reconciled?	What space is/ought to be available for reconciling different **worldviews** among those affected and involved?	Worldview Sacred/profane
Stakeholder influence matrices are used to map stakeholders according to their power and interest	How do the designers conceptualize who has influence over the design?	What conditions of success are/ought to be *outside the control* of the decision makers?	Sources of control
Surrogate stakeholders represent interests of those affected but not involved	How do the designers make boundary judgments about participation and their own selectivity?	Who is/ought to be the **witness** representing the interests of those negatively affected but not involved?	Sources of knowledge Second-order boundary critique
Stakeholder **onion models** diagram stakeholder categories according to their distance to the product or project	Marginalization: How are inputs recognized as sacred or dismissed as profane? What does it mean to be a *distant/indirect* stakeholder?	What opportunities do those negatively affected have to express their view beyond the worldview of the designers, i.e., to emancipate themselves from the designers' worldview?	Marginalization Emancipation
Goal models and social models such as i*	Whose goals get represented? What are the value systems implied by boundary judgments?	What is ultimately regarded as valid *guarantor* of success?	Sources of knowledge Sources of motivation Reference system

critical RE. Second, we need to examine in more depth the formal bias of RE models, moving down the set of activities in table 10.1 and reworking each through the lens of critically reflective practice. And, finally, we should examine the hidden values and value tensions in RE practice and theory itself. How should RE as a role, a profession, and a scientific community deal with the political nature of what it does? For this question, we enrolled another critical friend, whose friendship I will briefly describe.

DECONSTRUCTING CRITICAL RE

Feminist STS scholar Doris Allhutter describes "sociotechnical design as situated, embodied practice configuring new alignments between the social and the material" (Allhutter 2012, 685). She draws on deconstructivist feminist theory to develop the method *mind scripting*. Its objective is to allow teams to uncover implicit values and implicit positions, reflect on how subjects construct their own identities through discursive and material acts, and better understand how the performance of categories such as gender, race, class or sexuality intersect with their work. The method "allows a collective to deconstruct unconscious sense making and enables negotiations on the adequateness of implicit assumptions guiding decision making" (Allhutter 2012, 686).

With colleagues in the RE field, she and I used mind scripting to examine RE as a field. In the first Critical RE Workshop in 2020, we brought together "the analytic and modelling strengths of requirements engineering with the critical and social theories that can help our community better reckon with the social forces that shape technology design through requirements" (Becker, Betz, et al. 2020).

How does the collective process of mind scripting work? There are several steps to this method. First, a series of interviews leads to the crafting of a prompt. Our prompt was: *When they pushed the status quo in requirements work to acknowledge value-laden concerns . . .* Then, each member of the collective writes down a brief text describing a memory in response to this prompt. In one memory text, a situation was laid out in which a researcher team worked with industry partners. They used the sustainability evaluation framework of figure 1.2 in conjunction with a negotiation process called *EasyWinWin*, in which "stakeholders move through a

step-by-step win-win negotiation where they collect, elaborate, and prioritize their requirements, and then surface and resolve issues" (Grünbacher and Boehm 2001). Here is a part of this response:

> First, the other participants were a bit unsure if the CEO really had understood the different dimensions, but later it turned out that he actually had. For each of the requirements the CEO wanted to discuss, the people in the workshop were thinking of potential issues regarding each dimension. However, for most of the time the CEO was talking, which was a bit annoying, but his arguments were valid. He managed to cover different viewpoints, but of course it would have been great to actually have different stakeholders participating in the negotiation. For every issue, they also tried to identify possible options—ways to mitigate or even fully overcome the issue. Here, a lot of assumptions were made which made them feel that the process is a bit fuzzy and more based on opinions than on actual facts. Based on the list of issues and options for each issue, an agreement—highlighting the "best" available option—could be achieved. (Memory text, CREW2020)

During the workshop, these anonymous texts are collectively discussed, one by one, guided by a series of questions. This process of *deconstruction* "questions the normativity of discourses and practices by revealing the constructedness of seemingly 'natural' sense making" (Allhutter 2012, 689). Guided by Dr. Allhutter, the group explored how power is reproduced in RE and what kind of identity the text presented. The conversation was recorded, transcribed, and analyzed.

A central feature of mind scripting is that it "seeks absences and silenced contradictions that obscure the mechanisms sustaining hegemonies and power relations" (Allhutter 2012). As part of the method, silenced contradictions are pursued to uncover how seemingly obvious positions have been discursively constructed. At the second workshop, Dr. Allhutter (2021) showed us some results. The questions she surfaced included issues with parallels to CSH categories. For example, the memories showed that different kinds of knowledges were being negotiated. Facts about causal relationships and tradeoffs between sustainability dimensions were implicitly preferred over fuzzy opinions. During the deconstruction, the discussion shifted to the assumptions and value positions that underpin conflicting claims about tradeoffs. The method also surfaced power relationships between actors represented in memories. The author of the text above was keenly aware of the tension between the real world and an ideal

world in which the workshop would have happened with different participation, in different forms. Deconstruction also revealed an uncomfortable relationship between industry and academia: It felt to the researcher as if their product was *examined* in a test of the team's ability to construct something useful. Industry was calling the shots. In the common situation where short-term industry profits are in conflict with longer-term sustainability debts, there may not be any win-win outcomes. With power dynamics in play, the conventional method is unlikely to achieve its goals.

Even where mind scripting pointed to already familiar questions, it offered a new view, and it revealed entirely new perspectives on what we were trying to do that we could have never learned by following heuristics alone. For example, our critical friend made us aware of identity struggles and the drawing of boundaries between the "critically minded" and the supposed "others." A recurring issue was how *being critical* was negotiated, and how critical subjects constructed their own position through their texts. The discussion around my own memory text displayed this powerfully: I described what I experienced at a sustainability-oriented computer science workshop. A segment of it went as follows:

> Some ideas had crystallized into a proposal: to design a universal experimentation and evaluation platform that would be almost like a crystal ball, a platform to do it all: gather information from anywhere, predict the future, help us all transition to healthier lifestyles and policies. Some felt that the computing disciplines present could provide enormous benefit to the planet. They could put their forces together and help people make better decisions on the basis of such predictions. Others thought that this proposal could only be a critical idea, a story to remind them of the inevitable failures to predict emergent socio-ecological behavior, a reminder to explore the inevitable limits of success of this idea. . . . The compromise that ensued, more implicitly than explicitly, was that most of the proposal read like the system was to be designed, but a caveat text was introduced (and fiercely defended on several iterations) to state it as a "mechanism" or tool for examination. (Memory text, CREW2020)[13]

Deconstruction revolved around the difficult desire of intending to be critical but not paralyzed and how the anonymous author (I) negotiated this question, following a common idea of a continuum between a critical and a pragmatic attitude. By examining the deconstruction of my memory by our collective mind, mind scripting showed us how our conversation simultaneously constructed the subjects and objects of critique.

An important insight I gained was the encouragement to shift the target of critique: Instead of focusing on *the other*, ask what are the structural conditions of knowledge production that create this opposition? As Dr. Allhutter framed it (2021), we "need to analyze our own political circumstance to make transparent the social antagonisms/ideologies that obscure the workings of power in our epistemic norms, values and practices."

CONCLUSIONS

These brief vignettes cannot fully capture the nuance of this critical friendship or its developing insights, but I hope they show why I consider it an important help in the ongoing effort to reorient RE. Mind scripting can uncover implicit norms that CSH does not reach. This is partly because it engages with affective interactions during deconstruction. More generally, the two friends have grown up on such different epistemological grounds that they offer contrasting viewpoints. But both of these critical friends offer uncomfortable insights that computing will not find elsewhere. "By making us uncomfortable, critique contains within itself a transformative orientation" (Bargetz and Sanos 2020, 511). These insights arise only if we seek out these friendships, care for them, and listen. Getting into a zone of discomfort is a key step to overcoming insolvency. And it takes two for a critical friendship to flourish.

In this chapter, I critically examined the state of RE in light of the challenges of JSD. I illustrated how the myths depoliticize RE methods and practice, and I presented an attempt to restore the acceptance that RE is already political by uncovering and negotiating implicit values and implicit assumptions. The resulting critical technical practice for RE that I have presented here is not a complete or comprehensive method. I present it as an orientation and starting point to allow us to engage with the craft of RE while simultaneously remaining with one foot in the craft of critique. The introduction of CSH into RE practice supports the CST goals of reflection, emancipation, and pluralism. In contrast to value-based engineering approaches, CSH succeeds in making transparent the values in the assumptions and implications of modeling choices. Mind scripting adds an entirely distinct voice to the reorientation proceedings, a voice with its own history, melody, ways of speaking, arguments, and attitude.

The overlap of concerns and the complementary views that arise from each is striking.

Do I think that this is enough, that we just need to add CSH to RE and all the challenges will be resolved? Categorically not, of course. But that's the thing about leverage points: they are small changes that lead to bigger changes. I believe we have barely started and a lot to do. We will continue to be reliant on our critical friends as we reorient RE and other systems design fields for just sustainability.

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