Insolvent

How to Reorient Computing for Just Sustainability

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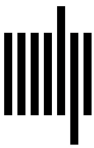

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11

SEARCHING FOR JUST, SUSTAINABLE DESIGN DECISIONS

Many citizens are ready to sacrifice for the greater good. We just need institutions that help them do so.
—Hauser et al. (2014, 222)

What if you found out you had a choice between a 92 percent chance of getting a delicious cacao olive biscotto from Toronto's Biscotteria Forno Cultura when you have read this book or a 66 percent chance of getting *two* of these marvelous cookies one month later. Which would you choose?

Have you made up your mind? Congratulations: You have made one of the many "intertemporal" choices you make every day—"decisions that involve trade-offs between outcomes occurring at different points in the future" (Frederick, Loewenstein, and O'Donoghue 2002; Loewenstein, Read, and Baumeister 2003). You have made many such choices before. In my favorite intertemporal choice cartoon, little boy Calvin and his tiger Hobbes are outside looking at piles of fresh snow (figure 11.1). Calvin feels torn. He must contain his evil urges to receive Christmas gifts: "my immediate pleasure is pitted against my future greed!" Hobbes sighs. "Poor Susie." But Calvin insists: "It's not a foregone conclusion!"

Researchers investigating intertemporal choice have noted that "most—if not all—choices that individuals and organizations make in the real world are intertemporal" (Soman et al. 2005). It follows that many, if not most,

11.1 Calvin and Hobbes face an intertemporal choice. (CALVIN AND HOBBES © 1993 Watterson. Reprinted with permission of ANDREWS MCMEEL SYNDICATION. All rights reserved.)

systems design choices are intertemporal too. But their temporal nature is not always recognized, acknowledged, and considered.

Since sustainability is all about future outcomes, this should matter a great deal: short-term choices are definitely bad for sustainability. If design teams tend to discount the future in their decisions, then we should counteract that, as the Karlskrona Manifesto on Sustainability Design suggests (see table 1.1). We need to understand how this process actually takes place to have hopes of intervening in it, especially if the delayed systemic effects that need to be considered are so complex and ambiguous. These decisions are complicated by the fact that who is affected is no longer a straightforward question. *Psychological distance* indicates how far an event is removed from direct experience. The concept encompasses the dimensions of time, space, social distance, and how real an event appears to be (Liberman, Trope, and Stephan 2007). The consequences of psychological distance in consumers have been studied extensively, and some researchers have investigated the larger implications of the underlying insights, including "why climate change doesn't scare us (yet)" (Weber 2006; McDonald, Chai, and Newell 2015).

How do intertemporal choices occur in systems design practice, how does psychological distance manifest, and how does all this affect sustainability and justice?

This chapter's aims are twofold. First, I introduce intertemporal choice and psychological distance and describe what we know about *how* people make systems design choices that incur distant effects, as all design

decisions related to sustainability and justice do. This view forms an important part of the diachronic perspective of just sustainability design. Then, I illustrate that in order to have a chance at genuinely shifting towards more just and more sustainable decisions, we need to reorient the theoretical frameworks and methods used in researching such decisions. By avoiding the normative fallacy discussed in chapter 7, we identify ways to ask better questions. I draw on my own research on intertemporal choices and psychological distance in software engineering (SE) decisions to make that argument, then connect it to studies of other researchers more directly focused on climate change.

Before that, another intertemporal choice. This time, you can be certain to get an entire box of delicious biscotti, and you have to pick: it's either delivered to you right when you finish reading, from a biscotteria that denies climate change, or about two months later, from a cooperatively owned shop that partners with women-owned organic farming cooperatives for all ingredients. Either shop will be paid for the purchase. Do these two biscotti boxes still seem equally delicious to you? How long would you be willing to wait for the second box? And how do you weigh these options?

JUST SUSTAINABILITY DECISIONS ARE INTERTEMPORAL CHOICES

Once we pay attention to the temporal nature of systems design decisions, it becomes apparent that intertemporal choices are ubiquitous and often ambiguous. Do I finish coding this new feature quickly so that it works for the deadline next week, or do I first design a robust architecture to make sure the feature can be easily tested and extended later? Do we spend another day testing the latest release or do we roll it out to our customers? Do I spend an extra hour writing documentation for my latest code while it's fresh on my mind, even though I don't seem to need it at the moment, or do I schedule two hours after the deadline to do it? All these are intertemporal choices in software development. The entire area of technical debt arises from design choices that are "expedient in the short term" but expensive later on (McConnell 2007).

Once we widen the horizon to consider the broader implications of design decisions, intertemporal choices are even more prominent, and the time horizon expands. Do we take the time up front talking to the

community about which issues they identify, or do we create a prototype for the first problem *we* identify? Do we undergo the effort to equitably involve a marginalized stakeholder group? Should the success of this project be evaluated on the day of its release, or should the project remain unevaluated until one year later? Should we build a feature into the system that allows users to extract all their data out of the database when the system is retired at the end of its life cycle? Do we spend time educating ourselves about the proper way to represent gender, or whether we need to represent it at all, or do I reuse this existing code that does? On the other hand, by adding code to store and process gender, aren't we just wasting time? If my team lead wants us to reuse a module using binary gender code because "it already works," how hard do any of us try to educate them on the value of gender diversity and fluidity? How do we evaluate the latest proposal to redesign our transaction processing system on the basis of blockchain tech?

All these choices are intertemporal and will have material implications for sustainability, equity, and justice. But the intertemporal nature of design decisions that affect sustainability may not be apparent until we make it so. Some of the outcomes of these decisions are uncertain, ambiguous, and removed not just from our immediate experience but also from our primary planning scope. These characteristics can easily tilt the evaluation of what should be done such that distant outcomes are overlooked or not evaluated with the same attention or weight as closer ones. As a consequence, many design decisions that appear relatively harmless contribute to what I have described in chapter 2 as the debts of computing. Performing a sustainability evaluation, even just applying the sustainability awareness framework based on figure 1.2, is one way to make these outcomes more apparent and consider them more fully. But this in itself is an intertemporal choice: Should we spend a week on evaluating and comparing the sustainability effects of these two alternative system architectures or should we pick one and move ahead?

INTERTEMPORAL CHOICES IN JUDGMENT AND DECISION-MAKING RESEARCH

There is a plethora of research on intertemporal choices in the area of judgement and decision-making (JDM).[1] Recall from chapter 7 that a

decision is a commitment to a course of action, a *choice* is a type of decision that involves the selection of an option, and *judgment* is a broader concept that involves reflective consideration of situational factors. When a decision or choice is intertemporal, it is often tricky to know what the best decision is. Individual choices will vary. *Temporal discounting* describes how a decision maker's valuation of an outcome changes when it shifts into the future. The classic model of intertemporal choice is the discounted utility model (Samuelson 1937). In this simple quantitative model, a person indifferent to the choice between receiving $100 in one year and $100 in two years is said to exhibit no discounting. Someone who requires an additional $100 in order to postpone the reward by a year is said to have a discount rate of 100 percent for that year.

A positive discount rate is common in studies, meaning that in general, people tend to favor positive outcomes when they are closer in time. But research shows that there is no permanent temporal preference built into our minds. A wide range of studies measuring discount rates in observed behavior across all sorts of decisions made by consumers have resulted in such a wild range of discount rates that a milestone review diagnosed "spectacular disagreement" (Frederick, Loewenstein, and O'Donoghue 2002). A natural explanation for this is that our brain is not a broken computer and that we consider many contextual factors when we make choices. Here we need to be cautious about avoiding the normative fallacy: the fact that we can describe behavior using a discount *rate* does not imply that the discount rate is the causal mechanism that causes this behavior. It is in fact extremely unlikely. The discount rate is an exponential function that compounds not unlike interest rates do. It does not take a lot of empirical research to understand we do not evaluate our biscotti preferences that way. If you picked the earlier biscotto, your inferred discount rate is 69.7 percent *per month*. Over a year, this amounts in removing 98 percent of the biscotto's value, leaving only a crumb. And how would you calculate the second version of the gamble using discount rates? Many would sooner give up on the biscotti than resort to this calculus.

Luckily, we do not need to model participants' intertemporal choice behavior as a simplistic function to ask interesting questions. There are other ways to characterize intertemporal choices, distinguish whether people exhibit temporal preferences, detect patterns, and explore what gives rise to these patterns. This requires a more systemic view. The *choice*

architecture concept describes how choices are framed, organized, and presented to decision makers (Thaler, Sunstein, and Balz 2010). Changes in choice architecture can "nudge" decision makers toward preferable choices (Thaler and Sunstein 2008). It forms part of the broader context of decision-making, which includes such aspects as team dynamics, organizational incentives, and values. In JDM, the broader system of these elements is called the *macro-cognitive* system (G. Klein et al. 2003; Maarten et al. 2017). We will return to it later.

INTERTEMPORAL CHOICES IN SYSTEMS DESIGN

In software projects, where I have studied this subject myself, the most explicitly intertemporal decisions surface in technical debt management, architectural tradeoffs, test automation, feature prioritization, and project management decisions (Becker, Walker, and McCord 2017; Becker et al. 2018; Fagerholm et al. 2019). These kinds of decisions specifically deal with options that have outcomes at different points in the future. However, intertemporal choices also surface in less obvious ways.

When I began to study these decisions myself, I opted for a conservative approach. To demonstrate to the SE research community that there was *something worth studying*, we had to conform to the expectations that would be enforced in peer review. So initially, we designed a behavioral experiment in the spirit of the rationalist tradition, aiming to evaluate to what extent software developers exhibit temporal discounting at all. In this recent study (Becker, Fagerholm, et al. 2019), replicated in several countries (Fagerholm et al. 2019), we examined whether software developers discount future outcomes. We chose an inconspicuous project management decision relatively unrelated to just sustainability to minimize ambiguity and complexity in the study design. We simply asked participants to indicate what time savings they would require to consider an uncertain positive outcome at different times in the future (potential effort savings) as equally valuable as a comparable closer outcome (feature development). In step one, we established an initial baseline for a fixed time horizon. In step two, we asked them again but for a set of time horizons, as illustrated in figure 11.2. This is a standard design for eliciting temporal preferences adopted from behavioral economics

You are managing an N-years project. You are ahead of schedule in the current iteration. You have to decide between two options on how to spend your upcoming week. Fill in the blank to indicate the least amount of time that would make you prefer Option 2 over Option 1.

Option 1: Implement a feature that is in the project backlog, scheduled for the next iteration. (five person days of effort).

Option 2: Integrate a new library (five person days effort) that adds no new functionality but has a 60% chance of saving you _____ person days of effort over the duration of the project (with a 40% chance that the library will not result in those savings).

(The only difference here is the timeframe.)

For a project time frame of 1 year, what is the smallest number of days that would make you prefer Option 2? ____

For a project time frame of 2 years, what is the smallest number of days that would make you prefer Option 2? ____

For a project time frame of 3 years, what is the smallest number of days that would make you prefer Option 2? ____

For a project time frame of 4 years, what is the smallest number of days that would make you prefer Option 2? ____

For a project time frame of 5 years, what is the smallest number of days that would make you prefer Option 2? ____

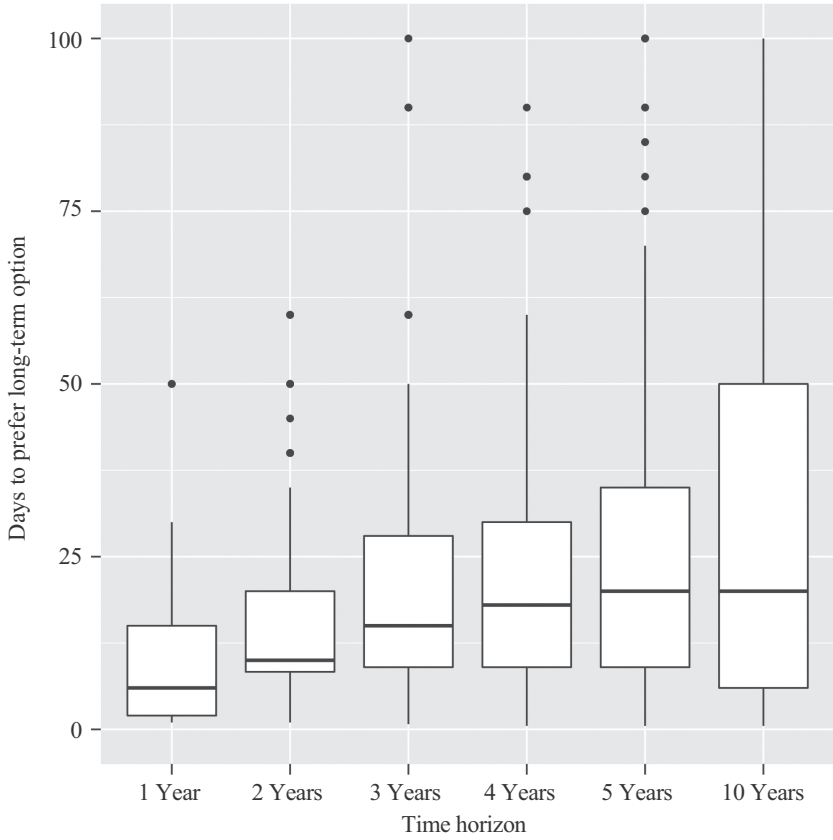
For a project time frame of 10 years, what is the smallest number of days that would make you prefer Option 2? ____

11.2 Intertemporal choice task used in our study, step two.

research (Frederick, Loewenstein, and O'Donoghue 2002; Hardisty et al. 2011; Becker, Fagerholm, et al. 2019; Fagerholm et al. 2019). I will use this example to illustrate how we should study decisions involving psychological distance before speaking more directly about just sustainability.

Figure 11.3[2] shows the aggregate responses for different project time horizons, with outliers above one hundred days omitted. The responses vary significantly but trend upward with increasing timeframe. Does this mean that our participants exhibit temporal discounting?

To answer this question, we sidestep the normative fallacy inherent in the temptation to calculate discount rates. Instead, we use a descriptive approach that does not rely on a normative model (Myerson, Green, and



11.3 Responses from a replication study on intertemporal choice in software projects.

Warusawitharana 2001; Fagerholm et al. 2019). We use the first response as the present value. For years two to ten, we calculate the ratio between the respective responses and the present value. The result expresses how temporal distance affects the responses and allows us to distinguish between three response patterns: some participants prefer temporally nearer outcomes, some are indifferent to changes in time, and some in fact prioritize distant outcomes over nearer outcomes (Fagerholm et al. 2019).

BEWARE THE NORMATIVE FALLACY

We still have to be careful interpreting these results. What do they actually show? All we know is that some people behave *as if* they would perform temporal discounting in this particular situation, and some (fewer) exhibit future preference. We have not identified how or why this effect takes place. We have most certainly not identified a processing module in their brain that computes a discount function. Performing an MRI scan of our participants would not change that. Nor do we have a "gold standard" of optimal decision-making. There is no "correct" decision to be made in the presented scenario. Many reasonable factors influence the evaluation of uncertain future outcomes. Many professional situations may be structured in ways that makes temporal discounting perfectly reasonable, whether because of job rotation and turnover, incentive structures, divisions of labor, business models, project cycles, system life cycles, or other factors.

We could still pursue the rationalist interpretation in the tradition of the heuristics and biases program, as many in the field do. We could treat any discounting as a mistake, focus on cognitive biases and supposed heuristic shortcuts, and aim to "fix" the discounting in our participants. The rationalist approach treats the situation presented in figure 11.2 as a case of choice under probabilistic uncertainty. The response is to handle it as a quantitative tradeoff problem and model its probabilities and benefits to recommend the optimal choice. But that is a problemist orientation to sustainable decision-making. Many practitioners will take a pass (Dittrich 2016; Becker et al. 2018). Because it treats the cognitive process as machinery, the rationalist model simply does not address the lived experience of practitioners and the difficulties they face when they try to exercise careful judgement.

I prefer to approach this topic as a human and social phenomenon and investigate why some participants took a long-term view without being asked for it; why many participants in their feedback inquired about a wide range of contextual factors that they felt were omitted; and to ask *how did you make your decision?* Only by understanding how they perceive the situation, how they reason about the factors they consider relevant, and how they evaluate their options, can we hope to identify paths to more sustainable and just design decisions in general.

WHAT LIES BEYOND THE MYTH OF RATIONAL DECISIONS?

How do we get a better understanding of intertemporal choices in systems design then? In another study with fifty participants from Colombia, Greece, and Sweden, my team and I began to use the insights represented in chapter 7 more fully. Our participants performed the task discussed above as a think-aloud protocol study, followed by a semistructured interview session in which they explained how they had reasoned and reflected on intertemporal choices in their professional life. The research design is a configuration of cognitive task analysis (CTA), the central toolbox of naturalistic decision-making researchers (Crandall, Klein, and Hoffman 2006).[3] What did we learn?

Half of our participants behave as if they discounted, half do not. For many professionals, shifting time frames do not merit discounting at all. Instead, they explicitly emphasize that the timeframe should not make a difference and therefore show an entirely flat discounting curve. One said: "Personally I'd place the same days of effort, it doesn't matter to me how long it is and how much is left . . . I felt that it's not relevant how long the project takes."

Intertemporal choices are ubiquitous in systems design practice. Almost all participants were quick to recall similar examples of intertemporal decisions they had personally faced. While they thought the scenario was artificial, they recognized the pattern of intertemporal tradeoffs. One mentioned that "this happens many times" and added that "in software development, this is constantly an issue . . . not that specific but in some form."

Intertemporal choice situations are often as ambiguous as they are uncertain. Participants often emphasized a lack of information, particularly with regard to precise numeric data on effort and probabilities of success, as in this case: "really this is . . . pretty much the way it usually looks . . . maybe there is even less information. . . . It's a bit harder in reality to [make the choice] at least from our team's point of view. We have not dealt so much with numbers."

Numeric methods are considered irrelevant. Many participants mistrusted the probability estimate provided by the scenario. When asked, "What information would you seek?," they requested (1) information to evaluate the chances of success, even though the probability was fixed at 60 percent; and (2) information to evaluate the trustworthiness of that estimate: Where did it come from? Who created it and how? What factors were considered? Many participants distinguished instinctively between uncertainty and ambiguity, in line with Camerer and Webers (1992, 325) finding that ambiguity, or the "uncertainty about probability," matters significantly in people's preferences. As a result, many of our participants seemed to ignore the numeric 60 percent estimate. Some explicitly mistrusted it, saying for example "Saving effort is difficult to quantify and also to understand." In addition to the raw number, then, our participants considered aspects such as the risk of secondary ripple effects of both options, even though those aspects were nominally captured in the estimate. In this and other matters, our participants demonstrated high reflective awareness. One put his unease with the limited perspective that methods often entail very succinctly: "When it comes to making decisions about time, using a method courts laziness."

Professionals appear to be more reasonable than methods. Many participants were aware of numeric methods but regarded them as inapplicable because they are unable to integrate nuanced qualitative aspects of reasoning that are more important, more reasonable, and more accurate than an artificially reduced numeric value. Even though the framing of the study encourages rationalistic reasoning (it suggests that numeric analysis is the appropriate angle for "solving the problem"), there is more evidence for cognitive processes of the naturalistic kind than for numeric reasoning. Participants relied on mental simulation and

heuristics to establish initial boundaries. For example, "at a minimum, the effort saved must equal the effort expended." Ultimately they considered a much broader range of factors than what was presented and contained in the probability estimate, and they drew on their experience to identify how to interpret the presented situation and evidence. Some thought it more important than the "mechanical" consideration of methods to bring multiple perspectives to bear on the question by involving other team members: "One perspective is not enough, cannot be enough, I need to hear other perspectives." When normative models insist on reducing all these aspects of uncertainty and ambiguity into numeric variables, they disregard the importance of judgment and thereby render themselves unreasonable and irrelevant.

Time perception is proportional. Amounts of time are not evaluated as numbers but in relationships to other amounts, such as the total duration of the project and the amount of time left. Most participants expressed that they perceived a specific length of time as long or short, or a future moment as "near" or "far." Participants tended to represent the meaning of numeric amounts of time as relative valuations, e.g., "a long project," "almost no time needed to finish the task," "very soon," or "in a long time." Relative valuation over time affects *both* options, but it affects them differently. That implies that it can shift the matching number because that number is relative to the perceived value of both options. This lends credibility to the relevance of *mixed outcome* discounting (Soman et al. 2005). In technical debt management, for example, paying down a technical debt involves a loss (effort investment) and a gain (architectural quality). Just as redeeming a coupon in Soman's study, the relative value of both loss and gain shifts differentially over time, but the actual choice involves both. That can imply that the attractiveness of paying down debt appears great as long as both loss and gain are distant, but it loses its appeal once loss and gain get closer.

Perspective matters. What distinguishes individual approaches to intertemporal choice? Different professional roles bring distinct perspectives. For example, a product owner communicating to a team might choose information that has a shorter time scale than what team members themselves see. This is also reflected in their decision-making process

in this task: participants in a specific role assume a certain frame with a certain set of information and have assumptions about other parts of the organization and the information they provide. In particular, participants asked for the source of the estimations given in the scenario and indicated that they would interpret them differently depending on where they came from.

Professionals demonstrate situational awareness. Several participants considered timeframes beyond those suggested. Some incorporated realistic longer-term effects into their evaluation. For example, even if the project would end in six months, if the project is successful, the system will evolve and then the decision to choose option 2 will have additional value. That value can hardly be quantified and occurs beyond the given time horizon, but it is quite reasonable to consider it. Similarly, several participants highlighted that they would need to understand the project environment to make a reasonable recommendation: They pointed out that company values and cultures, customer relationships and priorities, and established methodologies should all be considered. Decisions do not fall neatly into any particular method but are rather socially situated in the organization. As one participant noted, "each company is a different universe, it has a different culture, different methodologies. Even though many companies say they are agile, each [company] does [agile] differently, has different competencies, and different talent." This situational awareness is not a defect, it's a strength.

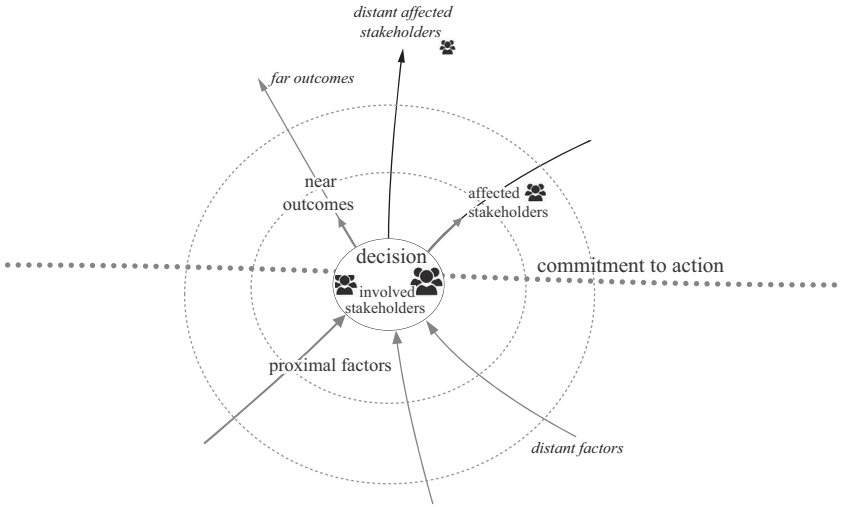
Judgment matters. Meaningful boundaries for supposedly technical decisions span social and temporal distances. Seemingly technical decisions always involve a range of social concerns. For most participants, decision-making begins with talking to a range of stakeholders covering the aspects entailed by the decision to be made. They recognize that the outcomes of intertemporal choices often extend beyond the current project and beyond operational measures. "We have a project right now, in fact, an internal tool for disseminating skills. I am probably a little more hesitant towards it than the team, but it is a huge morale boost for them, and it can work. . . . What tips the scales for me is above all the fact that they want to build it."

JUST SUSTAINABILITY DECISIONS INVOLVE PSYCHOLOGICAL DISTANCE

What do these initial findings about intertemporal choices tell us about the pressing challenges of decisions affecting just sustainability, where temporal distance seems to conspire with social distance and ambiguity to lure us into unjust, unsustainable choices? Yes, some participants sometimes act as if distant future outcomes mattered little to them. But others showed remarkable foresight. The outcomes are not simply a function of temporal distance. The participants in our study provide a much richer texture of how they reason about intertemporal choices than what a survey instrument or rationalist model can capture.[4] Their responses show us starting points we can use to develop a roadmap for the more complex, difficult decisions we need to work on. How do those participants reason who emphasize long-term perspectives? In our continuing analysis, we explore the factors our participants considered and the cognitive moves employed in their decision-making. We aim to identify patterns of short-termism and long-term thinking and develop interventions that help designers take a long-term perspective.

When we widen our horizon from internal technical perspectives to the larger, longer-term implications of design decisions, the intertemporal nature of decisions is complicated by the fact that the question *who* is affected is no longer straightforward. The decision-makers of the present may not be the ones who bear the consequences of their designs in the future. Instead, others with differing social proximity to the decision-makers will be influenced. Once again, it is the gap between the involved and the affected. Figure 11.4 loosely visualizes this "field" of decision-making, with its constantly evolving present horizon of commitments.

Psychological distance describes how the removal of an event from direct experience affects "the perception of when an event occurs, where it occurs, to whom it occurs, and whether it occurs" (Trope and Liberman 2010, 4). The four dimensions commonly thought to constitute it are thus temporal, spatial, social, and hypothetical. There is ample evidence that the dimensions are related but not in a trivial way. For example, we tend to use spatial metaphors to reason about temporal distance (Boroditsky 2000), and in many studies, the effects of social and temporal distance are



11.4 A sketch of the decision field.

marked when participants believe that the effects are real but much less pronounced when they are considered hypothetical (Pronin, Olivola, and Kennedy 2008, 233).

When an outcome is perceived as more distant on any dimension, it requires the mind to travel. Construal-level theory (CLT) suggests that our ability to do this is in fact a remarkable and rather unique ability of the human mind, and it involves some form of abstraction. We construe distant events in a different form than close events:

> The key to traveling across psychological distance, CLT suggests, is cognitive abstraction. Abstraction is a reductive process that entails extracting the essential, core (i.e., gist) aspects of objects or events while ignoring surface-level, or verbatim, features . . . abstraction allows one to extract those features that are likely to be invariant across different manifestations of objects and events . . . *high-level construal* . . . is central to traveling mentally to distant times, places, perspectives of other people, and possibilities. . . . High-level construal, however, does not necessarily produce more impoverished representations. Instead, it connects us to remote content, those things that may not be apparent in the here and now. . . . One can thus have rich and elaborated, yet abstract, representations of distant entities. As events become more proximal, we can incorporate the idiosyncratic and unique information that becomes increasingly reliable and available into our representations via a process of concretization. (Fujita, Trope, and Liberman 2015, 406)

So effects at a distance are not simply *less important* to us. Instead, construal-level theory suggests that we tend to pay more attention to higher-level features of distant events, that is, we think about them in more abstract ways, and when they are closer, they gain more granular texture in our perception and mental representation. This does not always cause us to devalue distant outcomes, but it shifts our evaluation. For example, for distant outcomes we tend to focus more on what we want to achieve than how, and we focus more on desirability and less on feasibility than for close outcomes (Fujita, Trope, and Liberman 2015, 415; Trope and Liberman 2010, 19). Decision-makers with social power perceive themselves as more distant to others and tend to emphasize more abstract representations (Trope and Liberman 2010, 27). This shift may have important implications for situations where we give advice to others:

> Any decision made about an issue generally affects decision makers to a greater degree than advisors. As such, advisors are more socially distant from decisions relative to decision makers. This change in social distance may impact the advice preferences of the two parties. Whereas advisors may prefer to provide information that preferentially weights desirability over feasibility, decision makers seeking advice may prefer to receive information that weights feasibility over desirability. (Fujita, Trope, and Liberman 2015, 414)

When we designed our first studies on intertemporal choice, we were intrigued by a prior study in which software developers exhibited a curious effect of psychological distance. They were asked to evaluate code for technical debt and then suggest whether the identified quality defects should be fixed or not. Remarkably, people were much keener on deciding for other people's defects to be fixed rather than their own (Amanatidis et al. 2018). In our own studies, however, participants made no difference between deciding for themselves or advising someone else.[5]

In all this, human decision-makers demonstrate cognitive flexibility, or the ability to adapt their reasoning to the situation at hand. The fact that some of our participants discount and others don't suggests that they perceive and evaluate different aspects of the situation. The diversity in demonstrated preferences should be reason for hope, not despair, as long as we are not looking for the "intertemporal defect" but rather what Klein calls the "sources of power": the remarkable cognitive abilities that human decision-makers demonstrate when they make decisions under uncertainty.

These abilities are especially pronounced in decision-makers with rich and varied experience (G. A. Klein 1998). In our study, we looked for any correlation between participant background and discounting. We thought that perhaps the amount of education or experience or the degree of responsibility would make a difference. Curiously enough, there was only one correlation, and it was none of those. Instead, only the breadth of experience, measured as the number of *distinct* responsibilities held in past jobs, made a difference—broader experience was correlated with reduced discounting (Fagerholm et al. 2019). With what we know now, it is not that surprising that those with more diverse experience would find it easier to traverse psychological distance, mentally simulate what would happen, and take it into account. This can carry significant practical implications for hiring, stakeholder participation, team composition, and the value of rotating responsibilities.

The abstraction implied in construal-level theory is consistent with the observation that "people pay less attention to subjective experience when that experience belongs to psychologically distant selves, that is, future selves and others, rather than when it belongs to psychologically immediate (present) selves" (Pronin, Olivola, and Kennedy 2008, 225). As a result, some suggest that "the salience, vividness, and emotional impact of choices decreases with psychological distance" (Pronin, Olivola, and Kennedy 2008, 234). But others emphasize that it is not necessarily the degree of emotional affect that changes but the type: "Research suggests, for example, that whereas low-level construal promotes the experience of lust, high-level construal promotes the experience of love" (Fujita, Trope, and Liberman 2015, 421).

These insights can help explain how the removal of the climate crisis and many aspects of social justice from the direct lived experience of many privileged people in the Global North may affect their willingness to act on it. In 2006, Elke Weber suggested that "the absence of (visceral) concern about global warming on part of the general public" is in large part because what she describes as the analytical processing system takes second rank to the affective system when we make risky decisions under uncertainty: "people's visceral reactions to risky situations often have little correspondence to more objective measures of risk that quantify either the statistical unpredictability of outcomes or the magnitude or likelihood

of adverse consequences. Instead, visceral judgments of risk (which fuel self-protective action) are determined by other situational characteristics that elicit affective reactions as part of our evolutionary heritage" (Weber 2006, 104). She highlights that empirical research on decision-making has been limited by the fact that researchers "have almost exclusively employed choice situations where the outcomes of risky choice options are (statistically) described . . . rather than personally experienced over time" (Weber 2006, 109).

TRAVERSING PSYCHOLOGICAL DISTANCE

Like others, I refuse to succumb to the fatalistic belief that we humans will boil each other on this planet like the proverbial frog in the water glass. But we have evidently no time to lose to activate our ability to "traverse psychological distance" (Liberman and Trope 2014) and make wise decisions. In *The Good Ancestor*, a plaidoyer and guidebook for long-term thinking, Tomas Krznaric (2020) argues that it matters a great deal how we think of ourselves. Our view of ourselves will shape who we become: "Changing the story about who we are makes a difference. If we keep telling ourselves that we are primarily driven by short-termism and instant gratification, it is likely we will exacerbate such traits" (40).

These stories about ourselves are not as innocent as they appear. In Calvin and Hobbes, Hobbes's name is key. For decades, the heritage of Hobbesian views, banishing any whiff of teleology from scientific accounts, has served to suppress ideas of purposive action in psychological and social science research. But more recently, the recognition has mounted that we do have some teleological capacity for purposeful action in our minds after all. *Prospection* enables our minds to mentally simulate navigation, the minds of other people, possible arguments for or against ideas, and counterfactual accounts of the past (Seligman et al. 2013). Come to think of it, it is quite remarkable.

And in contrast to the Hobbesian view that humans are wolves to each other, decades of research have recognized what Indigenous knowledges around the world have always emphasized: that humans are cooperative beings who live in and through relationships with the rest of the world.

When disaster strikes, the most natural and immediate reaction is not theft and destruction but mutual aid (Solnit 2010). And when humans are left to govern public goods in a way that resembles *the commons*—for example, partially renewable resources like fish—the outcome is not at all an inevitable destruction of all resources (Kimmerer 2013; Linebaugh 2014; Ostrom 2015). In a fascinating experiment, a group of researchers designed an *intergenerational goods game*, a version of a popular systems thinking game in which a group of fishers has to decide, through a number of rounds, how much fish to remove from an ocean. In the original game, the fish regenerate, up to a point, but it is common for the fish population to collapse due to overfishing (Sweeney and Meadows 2010). When simple communication mechanisms are established, however, it is common for groups to self-organize effectively and govern the common pool resource successfully. (That is in fact what happened when I played this game the first time with my students at the University of Toronto after they read Ostrom [2016] instead of Hardin. Mindset matters.) An important feature of this game is that everyone is in the room and can communicate with each other and that collapse may be at a distance at the time of fishing, but it happens very fast.

In the intergenerational goods game, asymmetric vulnerability is encoded into the rules of the game. Decision-making is fragmented into discontinuous groups, and future generations (groups) have no way of influencing past generations. The findings show that even under unregulated conditions, most participants cooperate with the future, at significant cost to their own success. But a small minority does not, and its behavior inevitably exhausts the common resource. When a very basic regulation by a democratic institution is introduced, however, two things happen. First, a basic robust voting mechanism is sufficient to contain the divergent greedy minority, if there is a mechanism to enforce it. In this mechanism, everyone votes, and everyone receives the amount of the majority vote. Second, cooperative behavior in this scheme is more common than in the unregulated condition. The authors' conclusions: "Many citizens are ready to sacrifice for the greater good. We just need institutions that help them do so" (Hauser et al. 2014, 222).

HOW TO STUDY JUST SUSTAINABILITY DESIGN DECISIONS

With these ideas at hand, I suggest that decisions in systems design should in general be characterized in terms of their commitment to action, uncertainty, psychological distance, situated cognitive processes, and context.[6]

1. The *context* in which the decision occurs is understood in the widest sense as anything that influences the decision.
2. *Commitment* describes which actions are available to commit to, and which is committed to. Decision-making is not always a selection out of explicitly enumerated options. There may sometimes appear explicit, well-defined "options" to choose between. But often, there are myriad ways in which to proceed, and some or all of the actions are generated by the decision-makers in the course of decision-making.
3. *Uncertainty* covers uncertain properties of the options and possible outcomes as well as their ambiguity. Uncertainty, or risk, refers to the objective probability of potential outcomes. *Ambiguity*, on the other hand, means that only vague information about the probabilities is available (Ellsberg 1961). It may be uncertain whether something will happen or not; to whom it will happen; and what it will mean at the time if it happens. The distinction between the two matters because they are and must be handled differently. Uncertainty about probability complicates how people think about possible outcomes when they decide.
4. *Psychological distance* comprises temporal, spatial, social, and hypothetical distance. The temporal dimension separates possible outcomes related to sustainability across time and can involve multiple timescales that need to be considered simultaneously. Time always introduces uncertainty about the outcomes and often also ambiguity regarding both the options and the outcomes. The social dimension often manifests as a distance between those involved in systems design and the justice-focused outcomes of their decisions.[7]
5. The *situated cognitive process* involves individual decision-makers possibly acting as a group. Psychological distance raises difficult questions about cognition that are not adequately understood yet. For example, people differ in their attitudes towards ambiguity: some are drawn to ambiguous options while others avoid them. Several studies indicate that attitudes towards ambiguity depend on the likelihood of the

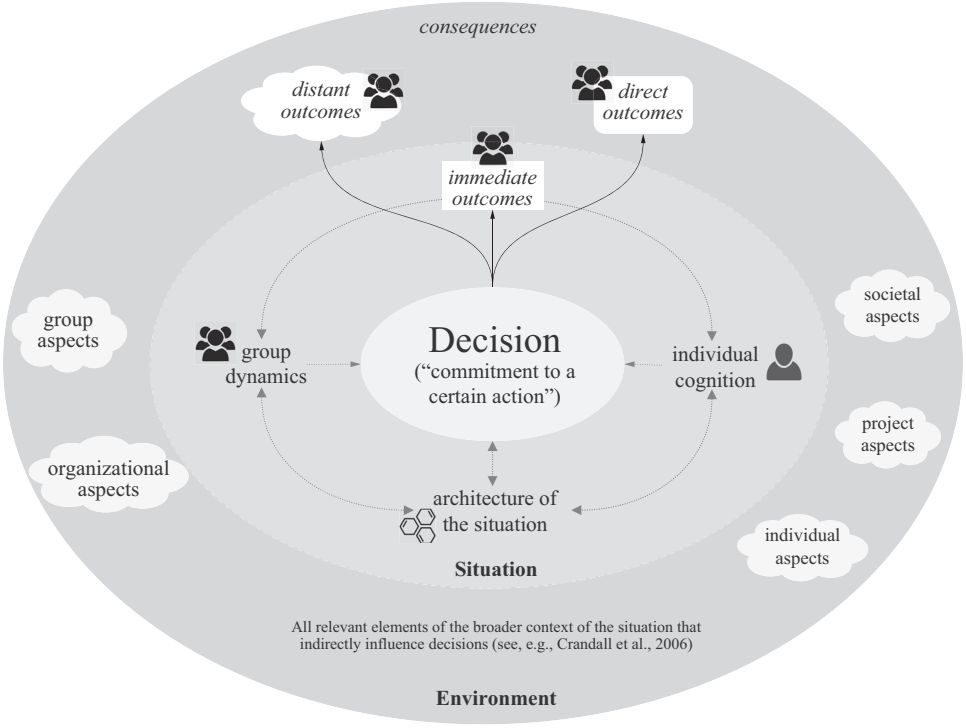
uncertain events, the domain of the outcome, and the source of the uncertainty (Trautmann and van de Kuilen, 2015). This means that decisions cannot be understood only through the temporal separation of the outcomes. It is crucial to understand how the outcome uncertainty is perceived by decision-makers.

Like other decisions, those with special import on questions of just sustainability should be characterized in terms of commitment, uncertainty, psychological distance, situated cognitive processes, and context. But in just sustainability, *psychological distance must take center stage*. The central sustainability choice could not be more clearly intertemporal: Do we save the planet now that we still can, or do we salvage the scraps later? But the truth is, we are not facing one big choice to save the world. We are facing a myriad of small and large choices. In systems design, commitments to future actions are constantly made and remade. For many of these commitments, their distant implications may not be salient and are significantly removed from direct experience.

To understand and improve the degree to which these decisions take distant outcomes more fully into account, we will need the whole toolbox of cognitive theories and the whole range of scientific methods. The legitimate role of the rationalist model here is to support a quantitative behavioral description of "as if" to guide our attention to the differences in behaviors, so that we ask the right people some good questions, and later, to measure how any interventions we may design affect behaviors. To understand how people actually reason, however, we need to rely on macro-cognitive methods, carefully reflecting on their scope and assumptions (Klein and Wright 2016). To support such research, we developed a framework for studies on decision-making including figure 11.5, a guiding map of key aspects that orients researchers toward central elements and relationships they should consider when studying decision-making.

CONCLUSIONS

In this chapter, a group of critical friends from JDM has helped us reorient our view of decision-making in systems design. This group too has already received some attention in computing before, but it has much more to offer us when it comes to understanding how psychological distance, and



11.5 A macro view of decision-making in systems design.

asymmetric vulnerability, shape the dynamic of just sustainable design decisions. When the effects of decisions are removed from our direct experience into a distance, we tend to shift our perception, evaluation, and preferences about them. The reasons for that are manifold. Psychology's most robust theory on this topic, construal-level theory, explains that our mental representations of distant outcomes focus more on high-level features, whereas closer outcomes are represented with concrete incidental detail. We also seem to perceive and represent temporal distance in proportional ways similar to spatial distance: future events appear smaller to us. As a result, decision makers in some circumstances behave *as if* they discounted future or socially distant outcomes. But we should be cautious about conclusions, predictions, and assumptions.

In describing, explaining, and prescribing how to design, we need to be mindful of human capacities and take a macro-cognitive view of design

situations. This attention can allow us to relate cognitive strategies, strengths, and weaknesses to the features in the environment that enable or constrain them. By recognizing which constellations are more conducive to traversing psychological distance, we have the best chances of making just and sustainable design decisions. In understanding how to change practice, we need to talk about redesigning decision-making situations as much as changing individual behavior. If the incentive structures we are all in have such a strong influence in generating unsustainable, unjust outcomes, then we must face the larger social context and structures surrounding those situations.

The human ability to envision outcomes at a distance is cause for hope. We are remarkably capable of moving across psychological distance. We possess what we might call temporal flexibility, which allows us to adapt our timescales and behaviors, switching from rapid chess under time control to strategic foresight to swift moves on a dance floor. We already possess the prospective capacity to mentally simulate the future and other distant places. And in the right circumstances, we are very capable of making decisions that are good for those affected at a distance, even if those affected are so completely removed that they have no way of thanking us.

But it must be said that we rarely are in the right circumstances these days. Systems designers too often get caught up in incentive structures that reward temporal and social discounting, set short-term objectives, ignore social and environmental debts, and structure employee behavior to fit that mold. The growth-obsessed mindset that favors short-term thinking dominates the capitalist IT industry. It is not conducive to cooperating with the future. There is no doubt that we need to redesign that environment. Some have already begun doing that.

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