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A cybernetic perspective on data feedback loops in complex soclotechnical systems

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Design for wellbeing during COVID-19: A cybernetic perspective on data feedback loops in complex sociotechnical systems

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Abstract: The COVID-19 pandemic has put wellbeing on the global agenda like never before. Many businesses, organizations, and even governments have recognized wellbeing as a formal policy goal. This paper addresses the question of how to design complex systems to improve the wellbeing of their stakeholders. We present a case of helping a university adopt a systematic approach to wellbeing assessment and improvement during the COVID-19 crisis. To support the improvement of student and staff wellbeing, we adopted a cybernetic perspective. Practically, this involved focusing on the design of a feedback loop that used wellbeing assessments to inform organizational actions. We argue that "off-the-shelf" assessments of wellbeing are often insufficient for supporting a systemic response to data because they lack context-sensitivity and actionability. While a "cybernetic perspective" may evoke a sense of the inhuman or mechanical in the optimization of wellbeing, our case study suggests otherwise. At least from our perspective, a society that aims to improve wellbeing may look more like a deliberative or dialogical democracy than an automated AI system.

Keywords: cybernetics; wellbeing; governance; pandemic; design for wellbeing

1. Introduction

The COVID-19 pandemic has put wellbeing on the global agenda like never before. Many businesses, organizations, and governments are recognizing the importance of human wellbeing. Currently, these systems tend to optimize for goals that generally do not align with wellbeing needs, at least not explicitly. For example, the success of a university is typically measured by its student's academic performance (and number of enrollments and graduates each year), and welfare metrics of nations are often aligned with economic ones (e.g., Gross Domestic Product). Increasingly, national governments aim for more than economic growth. Since the country of Bhutan changed its constitution in 2008 (Ura, Alkire

& Zangmo, 2012) to shift focus from gross national product to gross national happiness, the idea of wellbeing-based governance has become an intense topic of research and is called "Happiness Economics" (for review see Jain et al., 2019; Powdthavee, 2007) or "Wellbeing Economy" (Fioramonti et al., 2022). Despite this, there is a continued and pervasive gap between financial and wellbeing-based national economies. In the Netherlands, for example, the economy is returning to its pre-pandemic state faster than expected (CPB, n.d.) whilst indicators of population wellbeing are lagging behind (Brodeur et al., 2021). The COVID-19 crisis emphasized the need for systems that integrate wellbeing as their central objective such as schools, municipalities, NGOs (Allas, Chinn, Pal & Zimmerman, 2020) but also artificially intelligent (AI) systems (Floridi et al., 2018; Hendrycks et al., 2020; Stray, 2020). However, examples of methodological integration of wellbeing into optimizing systems remain fairly absent — artificial, economic, social, or otherwise defined. This leads to the question of what approach can and should be taken for integrating wellbeing metrics into complex systems — where one of the main challenges resides in the appropriate assessment of human wellbeing to model these metrics.

This position paper discusses a service that was designed to help a university integrate assessment and action feedback cycles to support student and staff wellbeing during the COVID-19 crisis in 2020 – 2021. We argue that "off-the-shelf" assessments of wellbeing are often insufficient for supporting system response because they lack a quality we call "actionability." However, by adopting a cybernetic perspective, we were able assess wellbeing at a contextual level, providing more actionable data. Lastly, we will discuss how our approach generalizes to other systems by giving an example of how it might aid in mitigating the risks of "Today's AI."

2. My Wellness Check: A wellbeing assessment system to support university governance

We designed a service called *My Wellness Check* (MWC) to help a large technical university in the Netherlands (University of Technology Delft) actively promote student and staff wellbeing during the COVID-19 crisis by supporting assessment-action feedback cycles. This meant that we first had to explore an appropriate way of assessing wellbeing. Because of the urgent and unfamiliar nature of the situation — a worldwide pandemic resulting in nationwide lock-downs — our first goal in designing the wellbeing assessment instrument was to ensure its sensitivity to the specific context we were living in. The second goal was developing the instrument with the purpose of gathering data that could inform the institution about opportunities for taking action. And thirdly, our intent was to improve the questionnaire experience which can lead to improved data quality (Baumgartner et al., 2021). As a service, MWC involves survey tools (see Figure 1), data reporting, and community analysis events. The primary intention of the service is to support a feedback cycle of wellbeing assessment and administrative action. We have since completed a total of seven of the assessment/action cycles (n = 18,476).

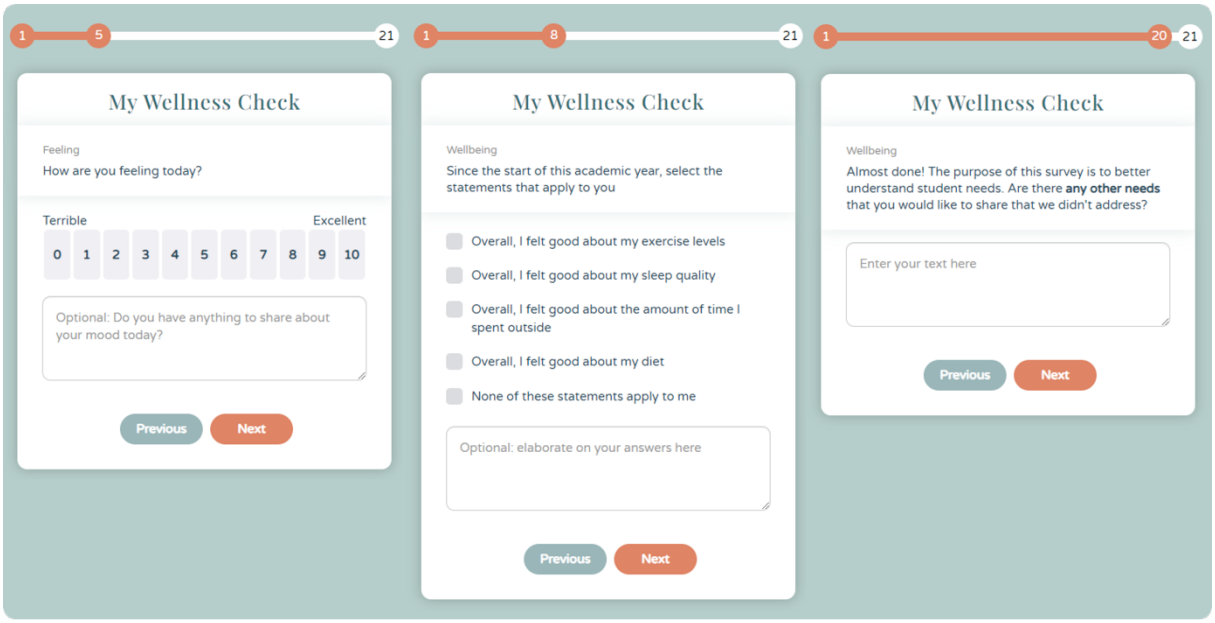

Figure 1. The user experience of "My Wellness Check" on a mobile device.

2.1 Context-Sensitive Assessment

Unlike many assessments of wellbeing developed in the psychological literature, MWC was not developed to validate different factors of wellbeing theory. Instead, we took a syncretic approach — i.e., drawing from many theoretical framings of wellbeing. When constructing the first iteration of the instrument (discussed in Lomas & van der Maden, (2021)), it became apparent that "off-the-shelf" metrics oftentimes lacked a quality we call "actionability." Actionability, in our understanding, refers to the degree in which a wellbeing assessment instrument can inform contextual action: "Do these results inform me about how I can *act* in response to the situation?" As an example, imagine that a teacher conducts a survey to assess how they might improve their course using the College Student Subjective Wellbeing Questionnaire (CSSWQ, Renshaw & Bolognino, 2014). Let's say that the results to the question "I am a hard worker in my classes" (Q5 in CSSWQ) are skewed towards "strongly disagree." At face value, this data is little informative on how the teacher might respond in order to boost student motivation — it requires more *richness* in order to inform appropriate action. Thus, in the interest of making our assessment instrument more actionable, we were especially interested in identifying and assessing the *concrete contextual manifestations of wellbeing* —as opposed to unspecific antecedents or indicators often found in psychological literature. We expected these context-sensitive items to be more actionable than items in typical assessment instruments because they are more fine-grained and directly point to opportunities for intervention. We anticipated that important theoretical factors underpinning wellbeing would manifest in the concrete situations of our context, see Figure 2.

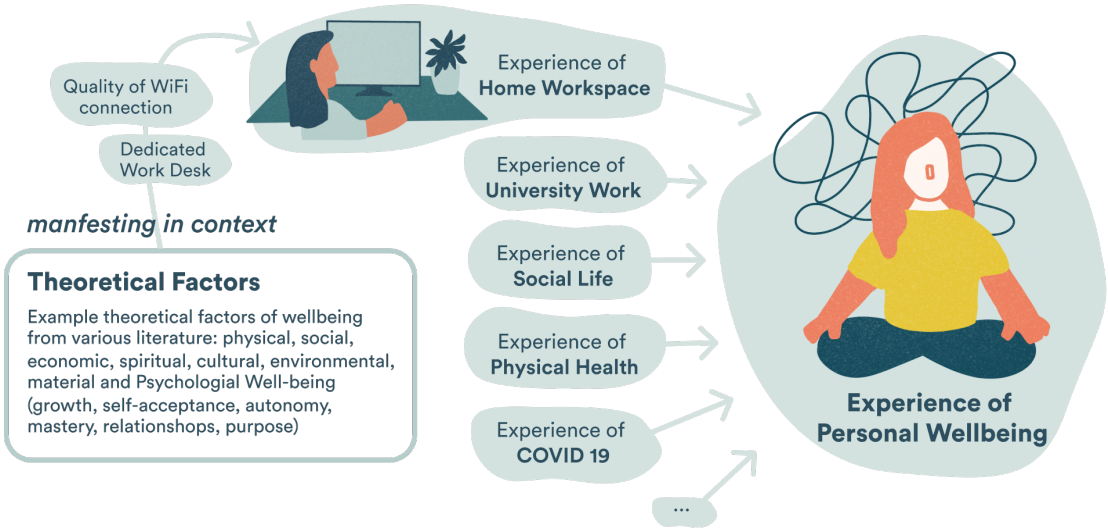

Figure 2. Theoretical models can manifest within a measurement context. This helps illustrate our orientation towards a syncretic model of wellbeing and our focus on context-sensitivity, adapted with permission from van der Maden, Lomas & Hekkert, 2022.

Concretely, this meant that we divided wellbeing into more specific sub-measures (like the experience of home-working space) that point to areas of life in which people do or do not experience wellbeing. For example, bad Wi-Fi or a poor desk chair can have detrimental effects on your experience of wellbeing while working from home. Note here that, we do not intend to say that assessing the quality of someone's chair is a measure of wellbeing. Rather, they are causal indicators to wellbeing — as understood in line with Wong & Law, (1999). Following this vein of thought, according to Mackenzie, Podsakoff & Podsakoff (2011), it is specifically items regarding these causal indicators that should be included in an assessment instrument. The specific causal indicators of wellbeing within a given context are what we call "manifestations'' of wellbeing. The manifestation of "material wellbeing," for instance, is likely to differ from one context to the next; in our context, we might assess this by asking about the ergonomic quality of respondents' home workspace — in another context, a refugee camp for example, this could manifest as the quality of housing offered. These manifestations can be assessed by what we call context-sensitive assessments that have been developed in conversation with university staff, students, and other stakeholders (e.g., policy-makers, counsellors, psychologists, human-resources) — a process that we will discuss next.

3. Human-centered design for context-sensitive assessments

To support the aforementioned dialogue, human-centered research activities have been employed including observation studies, focus groups, interviews, and workshops. For instance, we explored a range of different approaches to item development; we held over 20 separate sessions where we observed users as they filled out prototype surveys and

talked aloud about their experience — for brevity the specifics of the aforementioned and other design activities are discussed further in van der Maden, Lomas & Hekkert (2022).

By being in continuous conversation with students, staff, and organizational stakeholders, we were engaged in a deliberate and democratic process that informed us about the questions *we should be asking* (bottom-up). This is different from psychological approaches to survey development which typically involves the collection of psychometric data to confirm the researcher's hypotheses (top-down). For example, in developing the first staff iteration, through conversation it became clear that many staff members were struggling with their home-working environment. Thus, we included items specifically asking about the state of their home-working environment.

By combining quantitative questions[1] with qualitative ones (e.g., as seen in Figure 1), our analysis linked specific scores to a variety of written answers which often involved concrete suggestions on how the TU Delft could actively respond. Then, by creating a subset of our data from individuals who gave low (quantitative) scores for both life satisfaction and the quality of their home-working environment, we were able to derive two key issues from the qualitative data pertaining to this subset: 1) children that need attention and 2), poor desks and desk chairs. Although the former issue was outside the scope of the university's influence, they were able to directly address the latter. This resulted in a university-wide program in which staff members of the TU could order ergonomic desks, desk chairs, and other office peripherals. Hence, a clear example of how concrete suggestions gathered through contextualized assessment resulted in real-world impact. Next, we will discuss how we empirically evaluated our human-centered approach.

3.1 Evaluation of human-centered design approach

As mentioned, two our goals were to create an instrument that was sensitive to the unfamiliar and rapidly changing context, and to create a pleasant questionnaire experience. Sensitivity and questionnaire experience were assessed by randomly assigning students to either take My Wellness Check (that included context-sensitive items developed using human-centered methods) or either one of two other "off-the-shelf" wellbeing assessment instruments: the Warwick-Edinburgh Mental Well-being Scale (WEMWBS) (Tennant et al., 2007) and the College Student Subjective Wellbeing Questionnaire (CSSWQ) (Renshaw & Bolognino, 2014). We evaluated the experience based on validated questionnaire experience surveys (Baumgartner et al., 2021; Stocké & Langfeldt, 2004), for instance: "How satisfied were you with this questionnaire?" rated on a scale from 0 ("Very dissatisfied") to 10 ("Very satisfied"); and "Completing this questionnaire was worthwhile" rated on a scale

[1] Rather than only asking scaled questions, we also included several checkbox questions. With 5-7 items per question, the checkboxes allowed for investigating a very diverse set of phenomena with lower burden than independent Likert scales. This is relevant to context-sensitive assessment because the first iterations suffer from what is known as a *cold start* problem — in the initial iterations, you have to ask many questions about more surface-level phenomena.

from 1 ("Strongly disagree") to 5 ("Strongly agree"). Table 2 presents an overview of the results.

Examining a MANOVA showed statistically significant positive differences between our model and the two off-the-shelf models on all experience measures, the sole exception being perceived exhaustion. Furthermore, despite including a very diverse set of items in MWC, it was equally predictive of student "Life Satisfaction" as the WEMWBS, and more predictive than the CSSWQ. This evidence shows that our human-centered design approach improved sensitivity as well questionnaire experience in comparison to the "off-the-shelf" instruments. The human-centered design approach discussed in this section can be described as taking a cybernetic approach towards systems design (e.g., Glanville, 2007; Krippendorf, 2019; Jones & Kijima, 2018). The theoretical foundations of cybernetics and its importance to the design of systems that support wellbeing will be discussed next.

Table 2. An overview of the experimental results consisting of two parts. Firstly, the top row shows the correlation each model had with life satisfaction expressed by their effect size (R2) — i.e. the degree to which they were able to predict life satisfaction. Secondly, the table shows a comparison between the questionnaire experience of My Wellness Check (MWC), Warwick-Edinburgh Mental Wellbeing Scales (WEMWBS), and College Student Subjective Wellbeing Questionnaire (CSSWQ). The range for the question about satisfaction was 0 ("Very dissatisfied") to 10 ("Very satisfied"). For the other questionnaire experience questions, the range was from 1 ("Totally disagree") to 5 ("Totally agree"). The last row shows the number of questions and items in each respective instrument. Adapted from van der Maden et al. (2022).

	MWC	WEMWBS	CSSWQ
Correlation with Life Satisfaction expressed by R^2	0.53	0.51	0.42
How satisfied were you with this questionnaire?	6.9 (1.7)	6.2 (2.0)	5.9 (1.9)
This questionnaire was of high quality	3.8 (0.8)	3.3 (1.0)	3.1 (0.9)
Completing this questionnaire was of some value to me	3.3 (1.0)	2.9 (1.1)	2.6 (1.0)
Completing this questionnaire was engaging for me	3.2 (1.0)	2.8 (1.1)	2.7 (1.0)
Completing this questionnaire was exhausting	2.2 (1.0)	1.8 (0.9)	1.9 (1.0)
Completing this questionnaire was worthwhile	3.5 (0.9)	3.2 (1.0)	3.0 (0.9)
Completing this questionnaire was fun	2.9 (1.0)	2.7 (0.9)	2.6 (1.0)
Number of questions (items)	17 (78)	16 (16)	14 (14)

4. A cybernetic design perspective

The word cybernetics is derived from the Greek infinitive *kybernáō* meaning "to steer, navigate, or govern." Cybernetics in its modern sense was first described by Norbert Wiener in his 1948 book titled '*Cybernetics: Or the Control and Communication in the Animal and the Machine.'* Simply put, cybernetics is a transdisciplinary field that is concerned with processes

that internalize circular feedback to some degree — i.e., systems that have a feedback loop where outputs are taken as inputs for further direction.

A cybernetic system involves five parts[2]: sensors, actuators, a goal state, a controller or comparator (to determine how the actuators should respond to differences between the sensor data and the goal state; also known as a comparator), and an environment (which is treated as a causal part of the system). A simple example is a thermostat which senses the temperature of a room, compares it to the target temperature, and either turns a heater on (if the temperature is too low) or turns it off (if the temperature is too high) (Dubberly & Pangaro, 2007). Thus, translating this to our context, five parts can also be identified: wellbeing assessment (sensor), institutional action (actuator), improved wellbeing during COVID-19 (goal), university governance (controller), and students & staff (the environment) (see Figure 3). To reiterate, our goal was to develop a system that could inform an institution on how to take action in response to fluctuations in student and staff wellbeing. This was achieved by developing a context-sensitive assessment instrument through being in *conversation* with the constituents of the system — i.e., staff, students, counselors, policy-makers *et cetera*. *Being in conversation* with constituents of a system as framed from the perspective of cybernetics is viewed as a foundation for 21-st century design practice (Dubberly & Pangaro, 2019). Furthermore, in line with concepts from meta-design, involving the constituents of the system in the interrogation of the system (including its sensors, goals, and controllers) can be described as an open or evolvable system — as opposed to a closed system (Fischer & Giaccardi, 2006; Fischer & Scharff, 2000). How these theoretical perspectives externalized to our context will be discussed next.

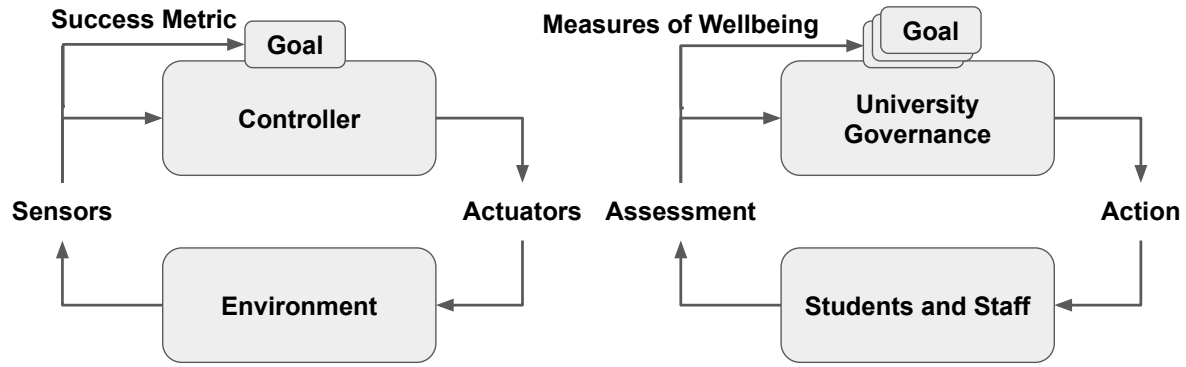

Figure 3. Illustrates the connection between a classical cybernetic system and the Wellness Check system.

4.1 Cybernetics and muddling through

Practically speaking, the context-sensitive assessments allowed us to identify opportunities for taking action. In this sense, we were taking action opportunistically, a design activity that

[2] The "parts" of a cybernetic system can also be referred to as its constituents (von Foerster, 2003).

Norman & Stappers (2016) describe as essential in solving the complex social problems we face today. They note that rather than (re)designing complex sociotechnical systems in one go, designers should be acting opportunistically taking whatever action is possible at the moment, in dialogue with a design vision (Hekkert & van Dijk, 2011). This process can be described as *muddling through* (Lindblom, 1959) — which essentially means taking action in small incremental steps to achieve system change. In this vein, our approach of integrating wellbeing into the university can be seen as *satisficing* (Simon, 1956) as opposed to optimizing — i.e., using aspiration levels to determine the best course of action when the optimal solution is indeterminable. We postulate that a similar cybernetic approach can aid in addressing the societal problems we face today — one of them being the mitigation of the risks of AI (Floridi et al., 2018). Because of its omnipresent and negative impact on wellbeing, and its reliance on measurement to take successful action, we want to discuss the application of our cybernetic approach to the problem of "Today's AI" and explore how it might aid in mitigating its risks as well as highlight the similarity of the challenges postulated by "AI" and "human" cybernetic systems.

4.2 Responding to "Today's AI"

In a recent call to action, Paul Pangaro (2021) articulates the need for responding to "The pandemic of Today's AI." This refers to the fact that "Today's AI" is embedded in innumerable devices affecting the lives of billions daily — in other words, a pandemic. The documentary "The Social Dilemma," (Orlowski, 2020) provides a good example of such AI. It shows us that by monopolizing our attention, some of these technologies *disengage* us from other people by *engaging* us in addictive behavior (Pangaro, 2021) and endless autoplay rabbit holes of extremism (Tufekci, 2018), ultimately harming our wellbeing.

In 2018, Mark Zuckerberg, CEO of Meta (previously known as Facebook), acknowledged the need for healthier digital platforms and announced that "We feel a responsibility to make sure our services aren't just fun to use, but also good for people's wellbeing." (Clifford, 2021) However, scientific literature describes that they have not fully succeeded in their pursuits (Stray, 2020). Conversely, according to internal memos published as the "Facebook Files," by optimizing for meaningful social interactions (MSI), "[Facebook] got angrier instead" (Hagey & Horwitz, 2021). Introducing MSI as a way to *solve* Facebook's problems is, we believe, an example of how AI-driven systems should *not* be redesigned to incorporate human values because of two reasons. Firstly, inferring from the aforementioned article (Hagey & Horwitz, 2021), a true human-centered approach was absent — a quality, we argued in this paper, that is essential to incorporating human values in complex system. To elaborate, the developers at Meta chose to design the system to optimize for objectives that were in line with what *they thought was right*. The designers decided how the theoretical concept of meaningfulness manifested in the platform instead of being in conversation about it with their user base. One can argue that the lack of a human-centered approach may have contributed to the reason why Facebook's teams "never really figured out why metrics declined" (Hagey & Horwitz, 2021). Namely, because the developers couldn't point

to anything concrete, they couldn't *attribute* changes in their metrics to design interventions — arguably because they had no contextual information. Secondly, Meta approached a complex sociotechnical problem (making a platform with billions of users more meaningful) by proposing a major overhaul of the platform's success metric, something that Norman, Diego & Stappers (2016) strictly warn against. Instead, designers should engage in taking incremental actions in the form of 'muddling through' with the aim of satisficing as opposed to optimizing.

To make our argument concrete: rather than redesigning the system for meaningfulness in one fell swoop, we believe that Meta should have instead taken a cybernetic approach, developing context-sensitive measures of meaningfulness in conversation with their users to facilitate muddling through and ultimately satisfice their system for wellbeing. For this reason, we would like to explore how our findings around MWC apply to the domain of ubiquitous AI. Especially regarding the question of how we can retain the granularity of our wellbeing assessment at scale and the relation of between muddling through and the "bottom-line."

5. Conclusion: "Cybernetic thinking" as an antidote for "AI-thinking"

This position paper discussed a case in which My Wellness Check was designed to help a university integrate assessment and action feedback cycles to support student and staff wellbeing during the COVID-19 crisis. We argued that "off-the-shelf" assessments of wellbeing are often insufficient for supporting system response to data because they lack a quality we call *actionability*. We have discussed that through a human-centered design approach, we were able to develop a context-sensitive assessment instrument that was more actionable, sensitive, and a better experience. We then addressed how this relates to cybernetic theory and emphasized why it is important to develop feedback cycles in order to integrate human values in complex systems. Lastly, we explained how this cybernetic perspective can aid in mitigating the risks "Today's AI" — a complex sociotechnical problem. The project from which the position presented in this paper has been developed, revolved mainly around a largely "human" cybernetic system. To develop our understanding further, we are currently seeking projects where we can apply our human-centered approach to ubiquitous digital systems. Especially, to explore what *conversation* means at the level of such large-scale systems and how it can be facilitated — that is; how do we preserve the granularity presented in our wellbeing assessment at scale.

To conclude, we propose that thinking about the complex problems of AI-driven systems in a cybernetic way ("Cybernetic thinking") can serve in attending to the dangers of algorithms that subvert human understanding and defy human control ("AI-thinking") (Krippendroff, 2021). Thus, to echo Dubberly & Pangaro (2007), we need to further develop a cybernetic language for integrating wellbeing into existing systems — be they artificial, economic, social, or otherwise defined.

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