

Figure 1: in5 frames 5 interrelated processes: move eat engage cogitate sleep (MEECS) as a model for Inbodied Interaction. Inbodied interaction, as a complement to Embodied Interaction, uses in5 as a design lens to tune the internal processes of the body (physio-neuro-chemical) to support embodied performance/aspiration.

KEYWORDS

inbodied; health; in5; inbodied interaction, embodied interaction

in5: a Model for Inbodied Interaction

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ABSTRACT

The human body is a complex system itself composed of complex systems; its state influences all aspects of our health, wellbeing including our cognitive to physical performance. In HCI most of us are not well versed in how this complex system works. The following paper proposes in5, a model to help make that physiology accessible for design. The model has two parts: (1) the MEECS dichotomies: five fundamental-to-life, volitional processes - move, eat, engage, cogitate, sleep - that are affected by parameters of quality, quantity, time and context, and (2) tuning: an approach to adjust the parameters of these dichotomies toward "dialing in" health, wellbeing, performance. The paper also offers examples for how this model can be explored for design research.

INTRODUCTION

The HCI community is increasingly interested in designing interactive technology to improve the health and wellbeing of the general population, where over 67% of the UK for example is underslept, overweight to obese, stressed and under-active (List 1). That said, very few of us working in this area have formal backgrounds in human physiology, nutrition, kinesiology, neurology, and so on, that inform our health and wellbeing. Based within sports science, physiology and neurology in particular, in5 is a model i have developed to make this complexity more accessible for designers. The model is situated in a broader approach to the body that i have called "inbodied interaction": interaction design that starts with an understanding of the body's physiological, internal processes as a path for design of body-centric [9], interactive technology. In the following sections, the paper situates "inbodied

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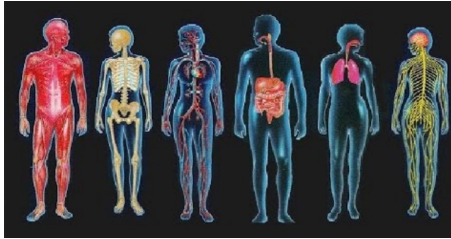


Figure 2: Figure showing 6 of the 11 systems of the body: non-volitional, autonomous, always on, always working together, providing constant signals about state, physiologic cues like heart rate, blood pressure, temperature, to hormonal cues like hunger, thirst, sleepiness, restedness.

Those 11 systems are: Circulatory; Digestive; Endocrine ; Integumentary; Lymphatic/ Immune; Muscular; Nervous; Renal/ Urinary/ Excretory; Reproductive system; Respiratory system; Skeletal

List 1: An Example of Normal: the UK

- 74% UK adults experience stress to levels "unable to cope" <https://www.mentalhealth.org.uk/statistics/mental-health-statistics-stress> £99BN/yr in costs to the UK economy
- 70% adults are under-slept, (http://www.rand.org/content/dam/rand/pubs/research_reports/RR1700/RR1791/RAND_RR1791.pdf) with estimated effects at £41BN/yr in lost productivity
- 67% of UK adults are Overweight to Obese costing £27BN/yr to the economy £6.1BN to the NHS (<https://core.ac.uk/display/19547453>)

interaction” within HCI discourse on the body; it details the in5 model in relation to this approach, and offers examples of how in5 can be used in design.

INBODIED INTERACTION: A PHYSIOLOGY OF EMBODIED INTERACTION

Epitomizing a key component of third wave HCI, Paul Dourish’s 2001 *Where the Action Is* [3] formalized what has come to be known as "embodied interaction." Embodied Interaction offers a socio-philosophical framing of the body as the Heideggerian mediator of all interaction: everything is mediated via the body. *Embodied* interaction considers psychological/emotive/social processes that are in turn impacted by physical/cultural contexts and so, produce lived experiences. The physical body itself, is largely situated as a black box, where its internal functions need not be specified beyond their inputs & outputs. This I/O can be manipulated for various effects, as theorised and explored in detail for example by: Loke and Robertson [8] around movement in "making strange" for design; Svan [13] in incorporating "the lived body" in design, and most recently, by Höök and colleagues in their soma aesthetics [5] to embrace the body and these functions for positive affect.

Inbodied Interaction (Figure 1) is proposed here as a complement to embodied interaction: its focus is to lift the lid of the black box, to look deliberately at the physio-neuro-endocrine and related functions that enable the lived body. Drawing on what I frame, from this perspective, as "inbodied sciences" like neurology, endocrinology, kinesiology, and also drawing on research in sports science/human performance, this functional, internal focus opens the design space of the body. The in5 model draws from these foci, and is offered as one lens for inbodied interaction exploration, modelling the kinds of questions/design challenges the perspective enables for researchers/designers.

THE BODY: COMPLEX SYSTEM OF COMPLEX SYSTEMS

Before presenting the in5 model, this section situates what in5 is abstracting: the body’s internal, always on, non-volitional systems. The body is composed of 11 highly complex, interacting, systems (see Figure 2). Supporting these systems requires energy: that energy goes where it is needed, constantly. Thus, these systems are highly plastic: constantly adapting to demand, or lack of it. As we learn a skill - playing an instrument, for example - neural pathways supporting that skill are *myelinated* (insulated) to become faster; muscle and bone tissue likewise develop to support these patterns. Similarly, tissue not used is reduced. For example, muscle atrophy occurs in astronauts when lack of gravity/resistance reduces demand for that tissue. These adaptive processes operate over the life course.

Our complex, autonomous, and always on 11 systems are finely evolved to support incredible resilience around our homeostasis (the very narrow tolerances of internal parameters that keeps us alive). For example, despite our capacity to live and thrive in climates from the very cold to the very hot, the core of our body has only a small band of internal temperatures in which it can function. If our core goes above or below these temperatures, by only a few degrees, we suffer system failures

List 2: The in5 MEECS Dichotomies

The in 5 MEECS can be refined as dichotomies that reflect a range:

- Move: at rest to in action
- Eat: fasting to feeding
- Engage: solitary to in company
- Cogitate: familiar to novel
- Sleep: asleep to awake

List 3: in5 Design Heuristics Two design heuristics can guide use of in5 for designing MEECS-oriented interventions:

- **(1)** *Focusing on any one MEECS strand to an extremes tends to pull the other strands down.* We often see this with our students during exams with narrow focus on Cogitation, to the exclusion of Move, Eat, Sleep or positive engagement.
- **(2)** *On the other hand, one can start anywhere to affect any other MEECS process,* eg: eating more nutritious foods can improve sleep, enhance energy to support movement and improve cognitive executive functions;

¹Constitution of WHO: Principles, <https://www.who.int/about/mission/en/>

² One additional related test is: is the absence of a MEECS is used as torture.

and sometimes in short order, death. As long as we maintain homeostasis, however, our bodies will attempt to muddle through with whatever other state we are in (underslept, poorly nourished, over stressed as per sidebar List 1). These states are all conditions highly correlated with disease risk, pain, impaired cognitive performance, absenteeism and premature death. And yet, the majority still go to work while being under-slept, stressed, in pain, etc. Culturally, we take these sub-optimal symptoms as normal and thus largely ignore them, until we cannot, and we break; when the cost of recovery from time off work, to costs for rehabilitation from drugs to therapy is far higher than if we had addressed these issues - or eliminated the norms that produce them -before they break us. We are, in a sense, too resilient for our own good.

A goal of **Inbodied Interaction** is to provide a path into the body's systems, to create tools aligned with the inbodied to better support the embodied expression of human aspiration, human performance; to build interactive technology to support the knowledge, skills and practice of how, literally, to *feel* better, individually and socially. The in5 model is offered as one path to explore that question.

THE IN5 MODEL

There are two components to the in5 model: (1) the "inbodied five" and (2)"tuning." The following sections describe each part. The core part of in5 includes the "inbodied five (in5):" fundamental processes that are literally vital - life giving - to achieve the WHO definition of health: "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"¹. These processed are **Move Eat Engage Cogitate Sleep** - or MEECS for short. The **criteria** in defining these processes has been to find the minimal set of (1) volitional processes that are (2) shared by all, are (3) physically based, and (4) have been shown to be correlated with mortality/quality of life². For example, Engage: we are neurologically wired to respond to physical, social engagement, from synchrony in team work to hormonal cues, like oxytocin [14] that correlates with social functioning around others [6]. Cohort mortality studies of people who engage actively with others, in physical contexts over the life course, are correlated with higher disease resistance, decreased prevalence of depression, greater quality of life [4]. For those who live more physically isolated lives, the opposite has been shown to be the case [12].

Each of the MEECS also interacts with each of the 11 systems: Eating, for instance, triggers hormones via nervous processes from brain to gut. What we eat affects tissue that can be built and what is expelled as waste: what becomes literally skin, bone and brain.

The MEECS Dichotomies and Parameters

Within each Process, we may ask where an individual is and where it may be better to be, in order to feel better/perform better. Each MEECS is itself a range of a dichotomy (as per List 2). For example, Cogitate moves from the Familiar to the New. We can interrogate the the same parameters of quality,

Inbodied to Embodied Connexions

In Embodied terms, all processes are mediated by the body. In neurophysiological [10], microbiological [2] and related inbodied sciences, the state of the body likewise aligns with all aspects of cognitive, physical, emotional, social, performance. Improving the inbodied enables, facilitates the aspirations and values expressed via the embodied.

Opening an Inbodied Design Space

A design advantage of the MEECS interconnectedness means that we can create benefit for any of the MEECS processes by improving any of the other MEECS processes. Thus, we can design sleep interventions that focus on movement, or social skills or improving gut as a path for enhancing sleep/recovery.

Design Opportunity: Design to support MEECS Choice: start where it feels safe, interesting, empowering

in5 Design Example 1: if a person has trouble sleeping, but feels it would be easier for them to go for more walks than get to sleep sooner, then improving movement, across quality, quantity, time and context this approach will both improve movement, and lead to beneficial effects for sleep [1].

quantity, context, time for each of these strands. For example, with Eat, questions associated with context include: where does a person eat? with whom? Time: when or how frequently? Qualities: what does one eat? Quantities: how much. These parameters can also be stacked together: Eat how much of what with whom when? See List 3 for associated design heuristics.

The in5 model also functions in cross section: that is, each of these essential but volitional processes interacts with each of the others. For example, muscle tissue is built in response to load placed on it in movement; that tissue requires nutrients from eating, and is built during sleep. The movement itself will be led by cognitive processes to develop a skill, and its resilience will also be affected by qualities of engagement around others - as these, for example will set off or soothe stress responses that impact capacity for skills development.

To go back to the 11 subsystems: unlike the volitional processes of in5, the 11 systems of the body are always on, always working and are all involved in each of these in5 volitional processes. After all, our body is one body, one system of systems, that combine to enable these in5 processes. Therefore to frame these processes as separable, though common, is largely problematic.

Tuning Metaphor

To avoid breaking, and indeed to improve wellbeing, the goal is to design systems to help us TUNE the in5 processes' parameters for wellbeing. Tuning in in5 resonates with several overlapping meanings. For the in5 to be "in tune" - to resonate together, like harmonics, references music - to keep instruments in tune against a reference tone; and engineering: to tune a system's components to work optimally together. A radio frequency metaphor also comes into play. A part of tuning the in5 processes is to improve signal clarity to better perceive signals the body itself is sending related to these processes. Both tunings are part of in five: how to TUNE the system, is fundamentally based on how dialing in our body signals, and resonating with these. Tuning is reciprocal; it's about how we feel.

Tuning is also based in the science of the body, and includes micro to macro scales and cycles. With movement, for example, quality, quantity, context and timing dimensions of in5 interact not only within a particular practice, like a fitness workout (a micro cycle), but across a season (macro): each phase varies intensity, practices, performance and recovery. When these parameters are not considered holistically (too much peak intensity for too long without recovery for example), we break [7]. Thus tuning incorporates temporality and variety, beyond just the now, and foregrounds the dynamics, plasticity and adaptive design must support for continued, improving, deepening quality performance of whatever embodied aspiration.

HOW WELL DO YOU FEEL?

For some processes of the body, we get very clear, strong signals, for instance when our homeostasis is disrupted. These signals are so strong, we cannot help but respond to them, even if we do not know

in5 Design Example 2: Tuning via in5 Eat Parameter

Rather than design to establish a habit (a repeatable, context dependent, autonomous practice) we can design to explore how to tune in *feeling better and performing better* with the in5 MEECS parameter, Eat.

Dialing In: How do you feel when...

We can, for example, design a self study experiment to help a person explore how they feel when adding green vegetables to their eating practices. An experiment may be eat some kind of greens before they eat something, each time - just for a week.

We can then help them evaluate the effect of the practice against asking both how they feel, subjectively as well as performatively, with testable values like:

- improved creativity
- reduced reactivity
- improved energy
- improved attention

I have described this self-study approach as "experiment in a box" as per <https://tinyurl.com/in5ogilvy>

what to do about them to get back to normal. Our bodies are however also sending us signals about less acute states all the time. We have built up practices seemingly deliberately to stop both hearing and attending to them.

An alarm clock is one of the most ubiquitous examples of signal suppression. We sleep to repair and build tissue and knowledge. The complex systems in our body are designed to put us to sleep and also to wake us up when that daily repair cycle is complete. An alarm is a deliberate interruption of that process: it does not let us our bodies complete the natural wake cycle. The consequences on everything from cognitive performance, to weight management from lack of sleep are significant [1].

There is both a significant need and opportunity for HCI to build technology to help us (1) gain awareness of how we truly FEEL - that is, of *all* our physiologic state signals - and (2) to learn what to do to respond appropriately to these signals. in5 offers a starting map to ask new questions around these 5 fundamental volitional, inbodied, processes. For example,

- Rather than focus on calories and macronutrients, we might design to build what we might call **SIGNAL AWARENESS**: Our design challenge may be for in5's Eating dichotomy from fasting to satiety, *what tool might help us discern real hunger signals from hedonic hunger pangs? or to balance hunger and satiety for energy?*
- Likewise, we can use in5 MEECS to build, say, **SIGNAL KNOWLEDGE** to build better choices: so how might we *how design to learn and experience how different foods at different times, amounts and places make us not only feel but perform better around qualities that are important to us* like: joy, compassion, anger, creativity, insight, patience.

CONCLUSION/FUTURE WORK: DESIGN WITH IN5

As shown in this paper, in5 provides a scaffolding for Inbodied Interaction design: it offers an interaction design framing that deliberately engages the internal complexity of the body (Figure 3). In5's foregrounding of the MEECS as inter-connected and inter-acting processes is a mirror of the 11 inbodied, automomous, non-volitional systems that drive them. In5 as a model of Inbodied Interaction helps connect these fundamental, shared-by-all, physical processes across the above sections' described suite of dichotomies, dimensions and contexts that can be translated into parameters of interventions to explore tuning not just of ourselves as individuals - but, looking to the not-too-distant future, tuning within our groups and communities as well - to help us feel and perform better, and from these insights, to help makeNormalBetter [11] for all, at scale.

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Figure 3: Example of exploring movement[9] via the embodied version of "making strange" [8], but through and for an embodied focus: we apply embodied knowledge of both proprioception and the vestibulo-ocular reflex in an embodied environment: a VR application that affects distance perception both (1) to help build Signal Awareness/Knowledge of (in)5's Movement and also as a Performance stimulus - in this case for enhancing Creativity.

Photos by m.c. schraefel

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