Interaction Restraint Framework for Digital Wellbeing

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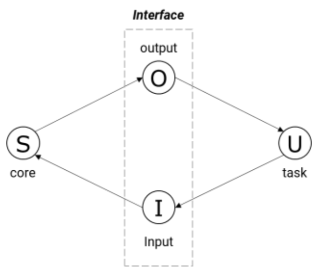
Abstract
User interface research in HCI mostly aims to minimize interaction friction for effective user interface design. To promote digital wellbeing, however, we argue that increasing interaction friction or even blocking user interaction would be beneficial. We propose an interaction restraint framework that generalizes existing restrictive user interaction design for self-regulating digital devices. We discuss design dimensions and related design concepts. Furthermore, we review several recent systems and suggest several research directions and challenges.

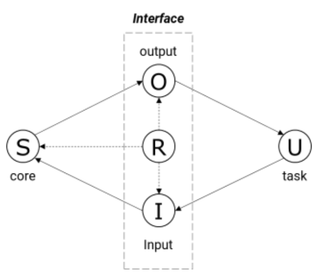
Author Keywords
Interaction restraint framework; digital wellbeing; restrictive and coercive design; intervention systems

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

Introduction
Digital wellbeing means that individuals, families, and organizations are capable of using digital technologies to help them to work productively, facilitate social relationship, and sustain healthy lives in a balanced way without experiencing negative side effects of digital technologies such as distraction, dependence, and health/safety/privacy threats. Despite the importance



(a) Interaction Framework [1]



(b) Interaction Restraint Framework

Figure 1: Comparison of Interaction Framework and Interaction Restraint Framework (U: user, I: input, O: output, S: system, R: interaction restraint). A user's task is translated into an input language, which will be used to control the system's core computing models. Outputs will then presented according to the output language. Interaction restraints regulate the input/output and system's core computing models.

of digital wellbeing, user interface research so far neglected how to design user interfaces that can effectively address negative side effects. Instead, its focus has been minimizing the gulfs of execution and the gulfs of evaluation, by supporting easy and accurate formulation of the actions and intuitive interpretation of the presentation regarding the goals.

Recent advances in mobile user interfaces provide easy and convenient ways of accessing a large amount of online content and services (e.g., music, news, and games) and maintaining social relationships. Such access gives instant gratifications to users (e.g., interpersonal utility, pastimes, information seeking, and entertainment). This reinforces continuous usage of mobile services and may lower a user's digital wellbeing, thereby leading to productivity loss, safety risks, and physical/mental health threats.

The majority of prior studies have tackled this problem with conventional behavior change strategies such as self-tracking/reflection to increase self-awareness and/or notification/dialog support to appraise and recommend positive behaviors [2]. Recently, researchers have explored various restrictive user interaction approaches such as selective and complete usage blocking, and have documented positive effects (e.g., reducing distraction and increasing productivity) [4, 5]. In fact, numerous commercial apps already leveraged such restrictive strategies (e.g., Apple and Google's Do Not Disturb modes).

Restrictive user interactions approaches are based on the commitment devices (or contracts) in behavioral theories: "an attempt to enforce people's voluntarily imposed restrictions until they have accomplished their goals, or their voluntarily imposed penalties for failing to accomplish their goals [7]." Examples include committing to losing money when failing to meet the gym attendance goal, or locking out a phone while driving.

In this work, we propose an interaction restraint framework that generalizes restrictive user interaction approaches for regulating digital devices, by extending the existing interaction framework. We provide related design concepts and review several recent studies to illustrate the framework. Finally, we provide several research directions and outlook the future of interaction restraints for digital wellbeing promotion.

Interaction Restraint Systems

Interaction Restraint Framework: Abowd and Beale's interaction framework [1] extends Norman's model by including interaction components (i.e., the system, the user, the input, and the output) each of which has its own language (i.e., the system's computing language, the user's task language, and the input/output interface language) (see Figure 1(a)). The interaction restraint framework extends the existing interaction framework by including the *interaction restraints* that intervene the input/output interfaces and the systems' computing models to intentionally create the gulfs of execution and the gulfs of evaluation for positive purposes (see Figure 1(b)). For example, the input interface's natural mapping can be altered to increase interaction costs, a user's certain input could be disabled, or a user may be even asked to perform an extra task to proceed with the intended task. A system's computing models could be restrained by choking computation/network speeds, disabling specific computing states (e.g., installation), or turning off the system after some time limit. A system's output interface could be restrained by lowering rendering/information quality and responsiveness. This means that interaction restraints can intentionally create the gulfs of execution and evaluation.

Design Dimensions: There are at least five essential design dimensions of an interaction restraint (i.e., target, type, trigger, time, and mutability) besides *who* sets the restraint (by oneself or by the others such as parents). First, the restraint target defines the scope on which restraints will be placed (e.g., user interface elements, apps, or entire devices). Second, the type defines how to restrain user interactions (e.g., blocking/degrading input/output interfaces, choking computing/networking performance, or redirecting to different tasks). Third, the trigger defines when a restraint is activated. A user self-imposes restrictions whenever it is needed (i.e., manual trigger), or the system may proactively impose restrictions based on usage behaviors (i.e., automatic trigger). Fourth, the time considers two aspects: the period during which enforcement is enabled (e.g., enforcing a 25 min lockout during 9AM-6PM); and the period during which a restrained mode lasts (e.g., a 25 min lockout). Finally, the mutability denotes whether a user can modify the restraint setting (and when and how).

Related Design Concepts: Interaction restraint design builds upon earlier design concepts such as mindful interaction [2], uncomfortable interaction [3], and inconvenient interaction [6]. Cox et al. [2] illustrated that decreasing fluid user interaction with design friction (by placing a small obstacle before an interaction) can increase mindfulness during user interactions (e.g., introducing short lockouts in number input tasks to minimize input errors). Benford et al. [3] argued that carefully and ethically engineered uncomfortable interactions (involving emotional or physical discomfort) can be an important design tool that can help achieve positive-long term goals. Likewise, Rekimoto et al. [6] conceptualized inconvenient interactions by which an interactive system encourages or requires a user to perform some actions as long as the actions may bring about positive benefits to the users (e.g., healthy eating, weight management). According to Tromp et al.'s definition [8], interaction restraint design lies in the persuasive and coercive design continuum, because a behavioral influence attempt is explicit, but its force of exerting behavioral influence could vary (e.g., weak vs. strong).

Case Studies

GoalKeeper [4] is a daily-goal based system that helps users to self-regulate smartphone use. This work investigates how restraint intensity (e.g., warning, vs. weak/strong lockout) influences goal setting behaviors and user experiences. GoalKeeper's interaction restraint considers the entire device (target) and considers different restraints (types): weak lockout (temporary lockout followed by a 15-min allowance time) vs. strong lockout (complete lockout until midnight). These restraints have different time durations. The interaction restraint is set on a weekly basis (time), and a user can modify their goals once per week (mutability). LocknType [5] is an interaction restraint system that triggers a lockout task with varying workloads when a user attempts to use target apps. A user can set a restraint on specific apps (target). The type of a restraint is a lockout task which must be completed to proceed with (type). This restraint is triggered at the start of target apps (trigger), and its workload (time) is dependent on the lockout task. The restraint was set immutable during the user study period (mutability), but mutability setting can be adjusted based on user needs.

Discussion and Outlook

Design Space Exploration: A systematic review of existing interaction restraints will enhance the framework and design space. Since interaction restraints are based on the commitment devices/contracts, it would be beneficial to leverage prior knowledge about the effectiveness (what works and why). There should be comparative studies of interaction restraints as opposed to traditional approaches (e.g., self-tracking, notifications). In addition, we could consider multiple devices or even a cyber-physical system, enabling opportunities of physical interaction restraints (e.g., turning off lights).

Context-Awareness and Intelligence: Prior studies [3, 4] showed that interaction restraints are useful for self-regulating digital media usage, but it also creates inconvenience due to lack of flexibility and context-awareness (e.g., usage in out of routine contexts). Thus, it is essential to understand a user's context and enforce interaction restraints adaptively.

Beyond Digital Wellbeing: Interaction restraints could be used for other purposes such as health behaviors (e.g., blocking the user input to avoid a repetitive strain injury). Further studies are required how interaction restraints can be used beyond digital wellbeing scenarios.

Towards Digital Wellbeing Agents: Various persuasive and restrictive interaction mechanisms will be incorporated into the cyber-physical systems. Further, a personalized, intelligent agent will help users to learn how to use the systems, but also guide them to better use digital technologies in diverse use contexts, thereby actively promoting digital wellbeing. Despite positive benefits, ethical concerns in the era of digital wellbeing agents should be carefully investigated.

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