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Towards Unified Principles of Interaction

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ABSTRACT

Even though today’s computers are used for many different types of
tasks, they still rely on user interfaces designed for office workers
in the 1980s. HCI researchers have produced a slew of innovative
interaction styles, from gestural interaction to mixed reality and
tangible interfaces, but they have not replaced traditional GUIs. I
argue that we must devise fundamental principles of interaction that
unify, rather than separate, interaction styles in order to support
the diversity of uses and users. I describe ongoing work on my
ERC advanced grant, ONE, which explores how the concepts of
information substrates and interaction instruments create digital
environments that users can appropriate and (re)combine at will.

1 INTRODUCTION

Today’s computers come in many forms and are used for a wide
range of tasks by a wide variety of users, yet their interfaces are
trapped in the same, 35 year-old model: each application is designed
for a single user, on a single device, with pre-defined tools to ac-
complish predefined tasks, such as editing a single document or
posting a comment to a single social network. Clearly, one is not
enough!

One user is not enough: Most applications, particularly for
authoring content, do not support multiple, simultaneous users, yet
most activities are collaborative. Therefore we need to support ubiq-
uitous sharing: Users should easily understand and manage shared
content; the infrastructure, not individual applications, should sup-
port real-time sharing of digital content.

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Even though today’s computers are used for many different types of
tasks, they still rely on user interfaces designed for office workers
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ERC advanced grant, ONE, which explores how the concepts of
information substrates and interaction instruments create digital
environments that users can appropriate and (re)combine at will.

One device is not enough: We juggle many devices, but they are
largely ignorant of each other. Distributed interfaces, for exam-
ple when a smartphone controls a slide presentation on a laptop,
are limited and complex. Therefore we need to support distributed
interaction: Users should be able to easily migrate and distribute
data, interfaces and functions across personal and public devices.

One document is not enough: Documents are trapped in ap-
lications, files systems and cloud-based services that isolate them
from each other, creating walled gardens and information silos. Yet
we constantly use inter-related digital artifacts that must be kept
together. Therefore we need to support owned content: Users must
be able to choose among different organizational principles to man-
age their digital content; applications and cloud services should not
own users’ data.

One application is not enough: Most applications are dedi-
cated to a small set of tasks and a single type of content and they are
not extensible. But the real world has no “applications”: we fluidly
design and redesign our workspaces to adapt to the activity at hand.
Therefore we need to support interactions as first-class objects: Users
should be able to easily select, fine-tune and appropriate their tools;
open environments should replace closed applications.

The goal of project ONE1 is to fundamentally re-think the con-
ceptual model and basic principles of interactive systems to empower
users by letting them appropriate their digital environment. Sharing
documents in real time, distributing content and tools across
devices and flexibly managing one’s digital environment must be-
come an integral part of the fabric of the digital world. This requires
a paradigm shift in the way we think of interaction.

2 A NEW CONCEPTUAL MODEL

HCI research has explored a number of interaction paradigms and
interaction styles, from gestural interfaces to mixed reality and
tangible interaction. Yet graphical user interfaces (GUIs) are still
the dominant paradigm. However the goal should not be to replace
one style by another, but instead to let users decide which style is
more appropriate for the situation at hand. To support a diversity
of interaction styles, we need unifying principles so that the various
styles can build upon shared concepts and representations.

I propose the concept of information substrate as the basis for this
unified conceptual model. A substrate is a digital computational
medium that holds digital information, possibly created by another
substrate, applies constraints and transformations to it, reacts to
changes in both the information and the substrate, and generates
information consumable by other substrates. Substrates are exten-
sible, composable with other substrates, and they can be shared.
They provide the fabric of the digital world.

1http://erc.one
The graph turns its input data into a set of graphical shapes. These aspects of the model, such as universal sharing [4] and layering [3], and distributed cognition; And we create systems to explore specific instrumental interaction [2] as well as on a number of theories, including affordances, enaction, technical reasoning, co-adaptation and distributed cognition; And we create systems to explore specific aspects of the model, such as universal sharing [4] and layering [3], and test them in real settings.

2.1 Example

Figure 1 shows a rich substrate. The data table is a substrate with column headings and an entry per row of the table. The data may come from a sensor, adding a new entry for each new reading. The table provides this information to a graphing substrate to plot it. The graph turns its input data into a set of graphical shapes. These shapes constitute yet another substrate, which a renderer substrate turns into a set of pixels displayed on the screen.

The graph that the user sees is therefore made of four substrates, each with its own properties, capabilities, and affordances. Different instruments (on the right) can operate at each level to add data to the table, change the type of graph, set the color of the bars, or edit the pixels to draw annotations. The color tool, for example, can also be used with other substrates, such as text or a paint brush.

2.2 Ongoing work

Our current work combines three strands (Fig. 2): We study how expert users deal with current physical and digital tools [5]; We refine the conceptual model, building on design principles from instrumental interaction [2] as well as on a number of theories, including affordances, enaction, technical reasoning, co-adaptation and distributed cognition; And we create systems to explore specific aspects of the model, such as universal sharing [4] and layering [3], and test them in real settings.

Next, we plan to create a significant collection of substrates and show that users indeed perceive the affordances of the stack that constitutes a digital object and of the tools that can be used with it. We also want to show that instruments and substrates can scale to an entire digital environment, and that instruments can work with substrates even if they were not designed for each other.

3 CONCLUSION

I believe that users should have better control over their digital tools. They should be free to use a GUI when sitting at a desk, a voice interface while driving, and a command-line interface when automating repetitive tasks. The goal of ONE is to provide a unified foundation based on substrates, instruments and environments, to create a more humane and more flexible digital world.

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