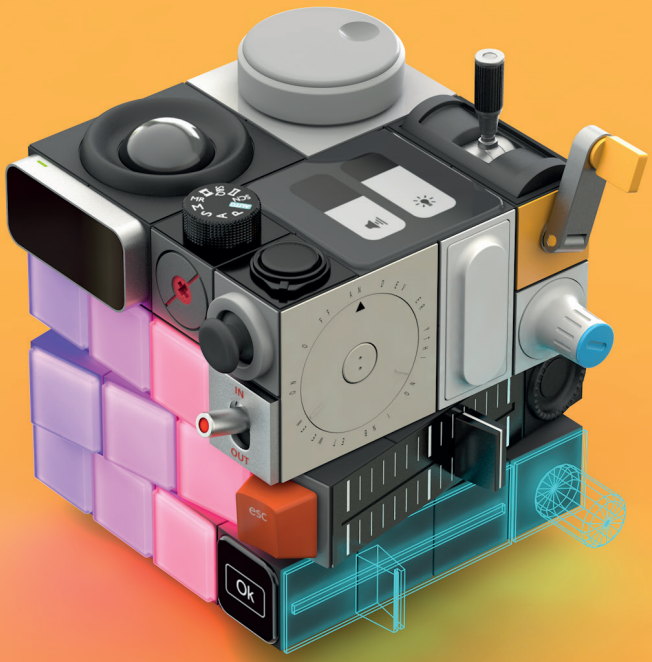
# Interface Design

Creating interactions that drive successful product adoption




Guillaume Couche, Richard Shackleton and Samuel Iliffe

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# Interface Design

Creating Interactions that Drive Successful Product Adoption

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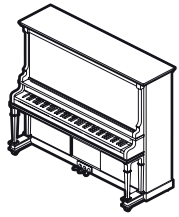
# Introduction

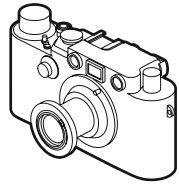
Throughout much of our history, machines were specialised, scarce and often shared amongst large groups of humans. Logically, their design was mostly results-oriented, intended to benefit the group rather than the individual. Consider a Roman catapult or a wood lathe — in both cases it is unlikely that anyone initially thought about 'user experience' during their construction. This remained mostly true until the emergence of machines such as the automobile and, later, the personal computer, in the twentieth century. Today, machines are ubiquitous, versatile and largely personalised. In fact, between cars, computers, home appliances, phones and other connected devices, we are surrounded by machines and spend most of our time interacting with one kind or another. This change of purpose has had significant consequences on machine design, with questions that sometimes revolve exclusively around the quality of user experience. Yet, if this was enabled by technological evolution, it also came from a change in the way we perceive a core element of machines: the interface.

For a long time, interfaces and their constituent inputs were functional parts of machines. Typically, a gear-shifting lever would act as a physical bridge between the hand of a driver and a vehicle's gearbox. With the invention of electricity came mechanical decoupling between the interface and the actual mechanism. However, the interface remained a functional part of the machine. A music amplifier knob, for instance, allowed for increasing or decreasing the volume of music by

modifying the resistance inside the machine's electrical circuit. This changed with the introduction of advanced electronics and computing, as it enabled the use of interface inputs that would not have to be integrated as a functional part of the machine itself. Previously selected based on specific mechanical or electrical properties, interface inputs like knobs could now be considered a means to gather user instructions in the form of an electrical signal, later to be processed electronically or digitally. The processed instruction could be used to drive various machine functionalities, opening up a large number of design possibilities — from input selection, to programming their behaviour.

Interestingly, the combination of virtually infinite options, and an interface independent from the machine itself, meant that interface design could suddenly be considered separately, sometimes secondarily. As a consequence, while new, innovative machines appeared, they remained only usable by a narrow typology of users. A typical example is the early computer that could be operated solely through command lines, requiring the learning of specific instructions and their syntax. Inventors like Douglas Engelbart saw how crucial it would become for humans to be able to use machines effectively. Their research led to the creation of a new design field — *interaction design* — and inspired visionary entrepreneurs such as Steve Jobs. In many ways, Apple's success can be seen as the history of a company that understood, earlier than its competitors, the importance of focusing primarily on interface design in order to build universally appealing machines.

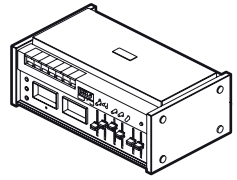




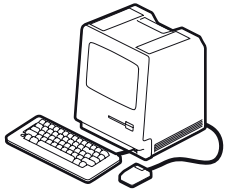
Age of
**Mechanical**
**Interfaces**

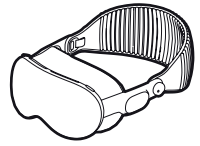
Introduction of
Electricity

Age of
**Electronic**
**Interfaces**



Introduction of
Logic Circuit

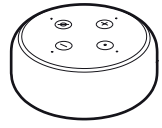


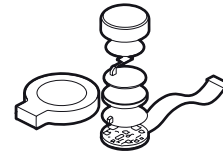


Age of
**Digital**
**Interfaces**

Introduction of
Sensors & AI

Age of
**Interpretation**
**— and Prediction?**





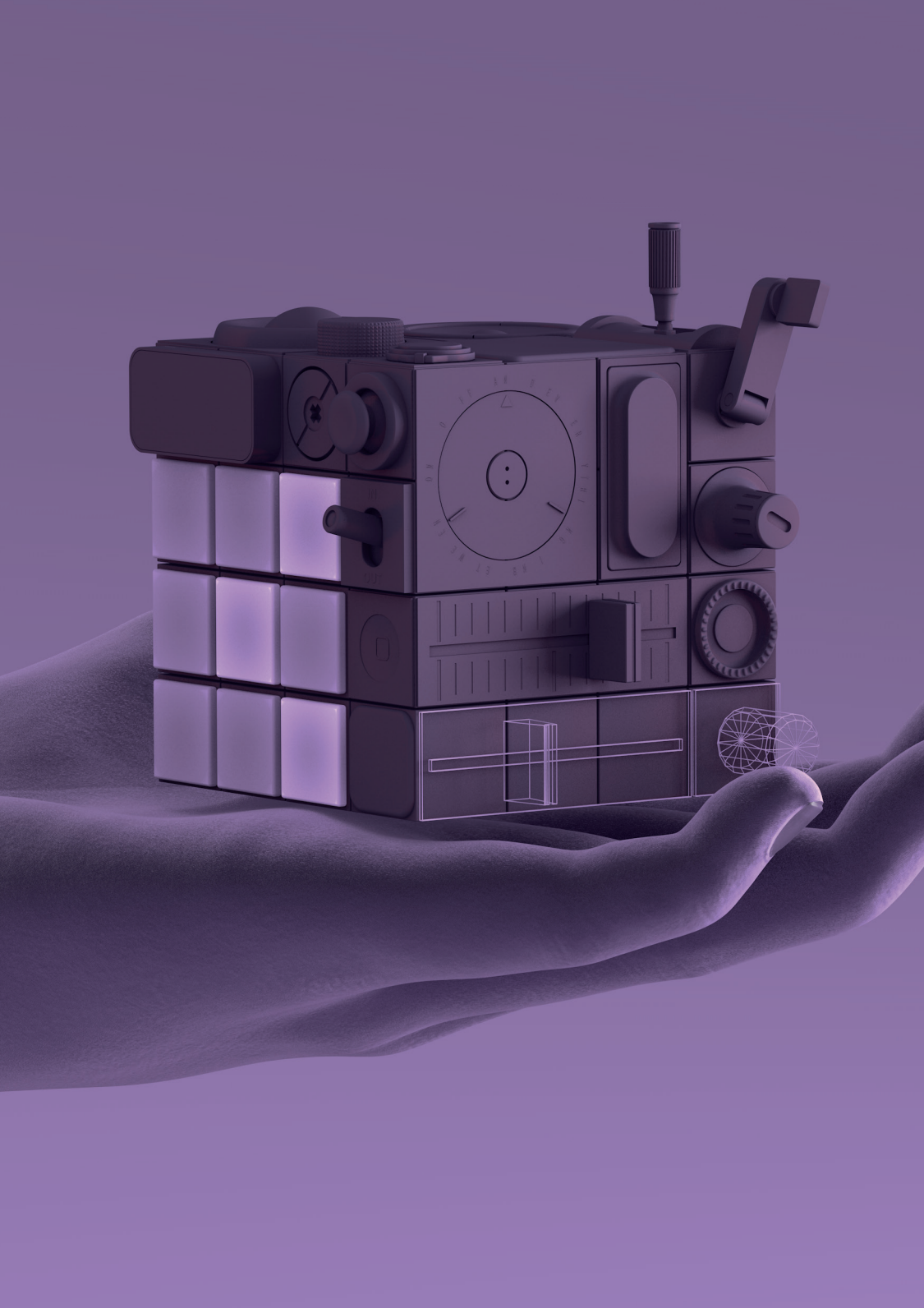
Today, interfaces are the keystone of every single product and service that sees the light of day. There are dozens of job titles that correspond to positions whose responsibilities are directly, or indirectly, related to interface design. While segmenting roles in large organisations is important to delineate responsibilities, it also establishes boundaries. Consequently, we see design practices that develop their own jargon and literature, sometimes overlooking shared origins and creative opportunities that arise from the cross-pollination of ideas.

Interfaces are rapidly evolving, and we might be on the verge of witnessing another major paradigm shift: modern sensors and artificial intelligence allow for interpreting, and even predicting, the user's intention without any active interaction. Beyond the complexity this adds to navigating the potential design opportunities, it also raises ethical and philosophical questions about the impact these changes might have on human agency and our ability to interact with one another.

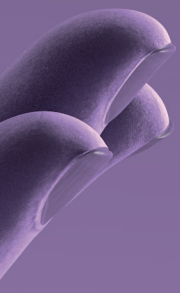
With this book, we aim to provide the widest lens for thinking about machines and their interfaces for all designers, product managers, engineers, hobbyists and creatives alike, whether one's experience and interests lie in industrial and product design, spatial computing and virtual reality, user interface (UI) and user experience (UX), interaction and installation design, or software and application development.

*Authors' note: for simplicity, and to avoid repetition, in the following chapters we describe the general case — that is, mostly hand or finger actuation. However, most concepts and principles can be implemented for any type of body actuation (hand, foot, elbow, eye). Other concepts (e.g. language-based interaction) do not rely on body motion at all. While we considered rating these concepts based on an 'accessibility' criterion, establishing absolute terms proves challenging as it depends on the specific needs of the individual, applications and final design. Given the extensive overview of the interface landscape, we believe this book can be used as a helpful tool to invent solutions and find alternatives to make interfaces more accessible. Ultimately, it comes down to one simple question when working on a new design: does it also work for people who are not like me?*

*‘Apple’s success can be seen as the history of a company that understood, earlier than its competitors, the importance of focusing primarily on interface design in order to build universally appealing machines.’*



# 1/ Definitions



In this chapter, we provide an overview and reference base for specific and recurring concepts used throughout the book. While the definitions given closely align with the primary usage in the English language, we often restrict the meaning of specific terms for the purpose of disambiguation. Conversely, we occasionally provide widely recognised definitions to insist on the wider lens we apply to them. The presentation is primarily organised by association.

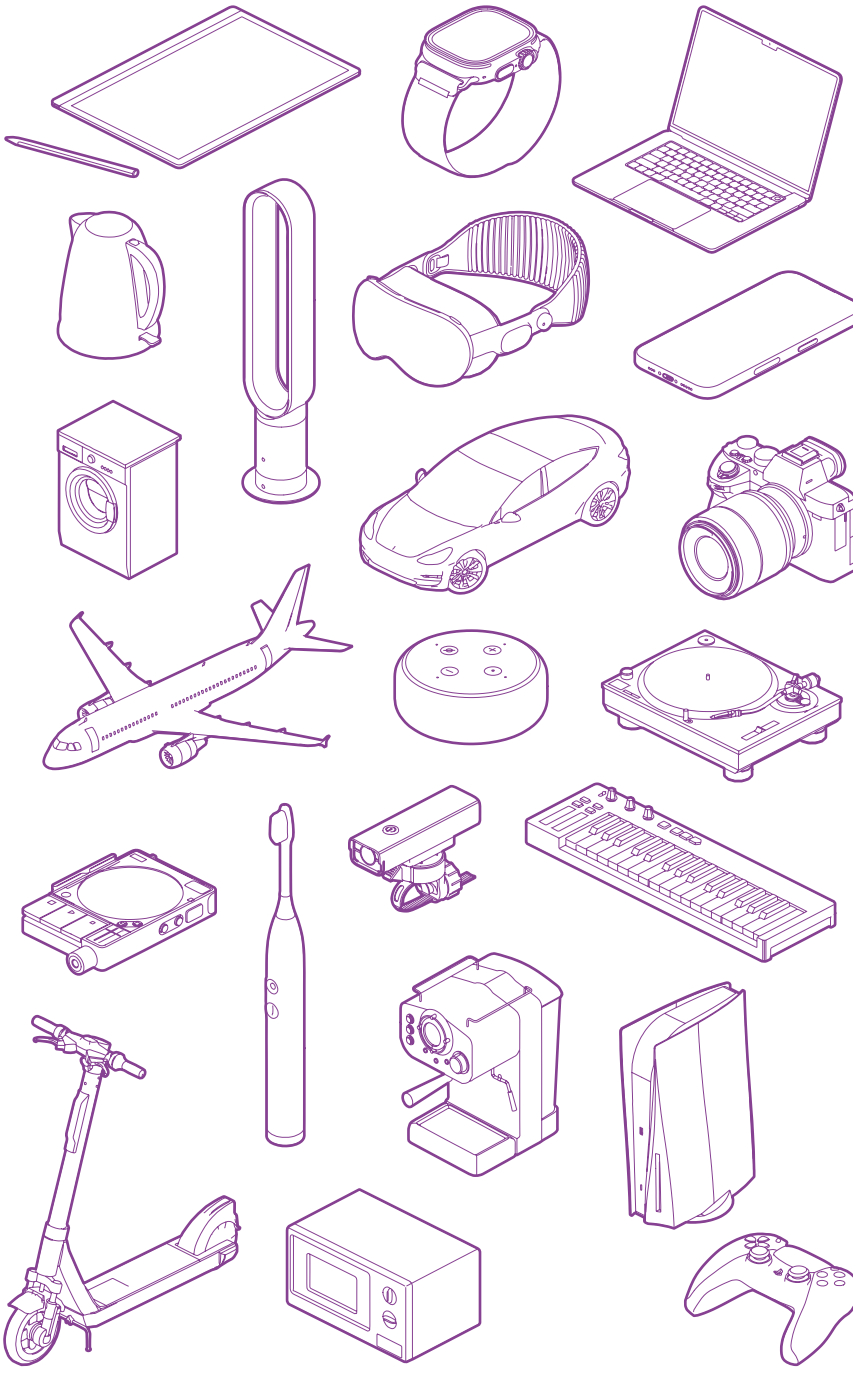
## Machine

We consider the term 'machine' in its widest meaning, to designate any object, physical or virtual, with interaction capabilities. Typical machines we use in our daily life include cars, smartphones, speakers, cameras and kitchen appliances.

> **Computer:** while it has become commonplace to consider nearly every machine as a computer, for clarity, we reserve this term specifically for personal computers, tablets and smartphones.

## Interaction

A 'human-machine interaction', or simply an 'interaction', is a set of actions performed alternatively by a human and a machine, with multiple potential outcomes. Interactions are sometimes metaphorically described as the dialogue between the human and the machine. Pressing a sequence of buttons on a phone keypad *is* an interaction. Using a mouse to create digital content on a computer *is* an interaction. Exchanging with a chatbot to access one's bank accounts *is* an interaction. While some hold the view that the term 'interaction' can only be used when the outcome cannot be predicted by a simple action-reaction mechanism, the distinction is becoming increasingly hard to make when machines are all becoming intelligent. Today, there is, in practice, no base unit for what is deemed an 'interaction'. For instance driving a car, with all that entails, and turning the wheel can both be considered interactions, even if the former contains the latter.



**Active interaction:** an active interaction is the default interaction, and this is what people usually refer to when they speak of 'interactions'. It always follows a conscious decision from the user to engage with the machine. If the interaction is not active, we speak of 'passive' interaction.

**Passive interaction:** contrary to an active interaction, where the user *makes* a decision to engage with a machine, a passive interaction can happen without this intention. For instance, a portable speaker might be designed to play music when someone comes within a specified detection range. Whether or not this person is the primary user, i.e. the user who installed the device, a conscious decision may not have been made for the interaction to happen, *at the moment it happens*. Hence, this is a *passive* interaction. It is worth noting that passive interactions can go beyond automations and routines that would have been set up by a human. For instance, the device described here might use artificial intelligence to perform actions such as changing the music based on the assumed mood of the user.

**Routine:** usually set up by the user, a routine is a predefined procedure allowing for automating the actions performed by a machine based on data collected by a sensor, or a set of sensors. A typical home automation routine is to switch on the heating when the temperature drops below a certain level.

## Interface

An ensemble of inputs and feedback systems that allow for interaction with a machine.

**Physical interface:** sometimes referred to as a 'human-machine interface', a physical interface is made of hardware inputs such as physical buttons, knobs, sliders, or sensors. A computer keyboard is an example of physical interface.

**Graphical user interface:** a graphical user interface (GUI) is an interface made of software inputs such as virtual buttons, knobs and sliders, represented to the user by means of a display or headset (e.g. spatial computing). A smartphone menu is an example of a graphical user interface. User experience (UX) and user interface (UI) designers specialise, amongst other things, in the design of graphical user interfaces.

**Primary interface:** a graphical user interface always requires a physical interface to act as an entry point for the user to interact with it. Typically, operating a smartphone menu (graphical user interface) requires touch interactions on the device's touch screen (physical interface). When the distinction needs to be made, we speak of 'primary interface' for the physical one.

## Input

An input is both the entry point and mechanism by which a human can interact with a machine. See Chapter 2 for more details and a list of the existing families of inputs.

**Component:** throughout the book, the term 'input' is used to describe general concepts and, sometimes, their implementation. We speak of 'hardware component' or just 'component' when we refer to the underlying technology of a given input.

**Maintained:** an input is described as 'maintained' when it keeps returning the last state, or value, it has been set to by the user. The opposite of 'maintained' is 'momentary'.

**Momentary:** an input is deemed 'momentary' if it always returns its default state, or value, when not in operation. The opposite of 'momentary' is 'maintained'.

**Signal:** when an input returns continuous values we speak of 'signal'. For inputs with set boundaries, the signal can be represented as a percentage of the full input range. Typically, the signal of a slider could be anything between 0% and 100%.

**States:** when an input returns discrete values we speak of 'states'. Typically, a button input will return 1 when pressed and 0 when not. States are often characterised using words rather than values to avoid ambiguity. In the previous example, 1 would be referred to as 'ON' or 'ACTIVE' and 0 as 'OFF' or 'INACTIVE'.

## Spatial computing

Spatial computing is an umbrella concept that covers all the computing interactions happening outside of the boundaries imposed by traditional computers and flat graphical user interfaces. We use it specifically when it involves immersive three-dimensional (3D) technologies such as virtual reality (VR), augmented reality (AR), mixed reality (MR) and spatial audio.

## Kinaesthetic

We use the term 'kinaesthetic' when a specific concept relates to the user's awareness of the position and movement of their body, or parts of their body. 'Kinaesthetic memory', for instance, is a central mechanism through which humans learn to play an instrument, while 'kinaesthetic mapping' describes our ability to intuitively find our way on an interface. An input will be described as providing more or less 'kinaesthetic feedback' depending on how much it lets the user feel the movements necessary to operate it (see Chapter 3 for more details).

*'Interactions are sometimes metaphorically described as the dialogue between the human and the machine.'*