

Bootcamps for Emerging Technologies and essential Skills



Topic 3: AR, VR, HMI, UX, GUI



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Bootcamps for Emerging Technologies and essential Skills



Consortium

Co-ordinator:



Partners:



What will you learn in this bootcamp?



Human Machine Interface (HMI)



User Experience (UE)



Graphical User Interface (GUI)



Virtual Reality (VR)



Augmented Reality (AR)



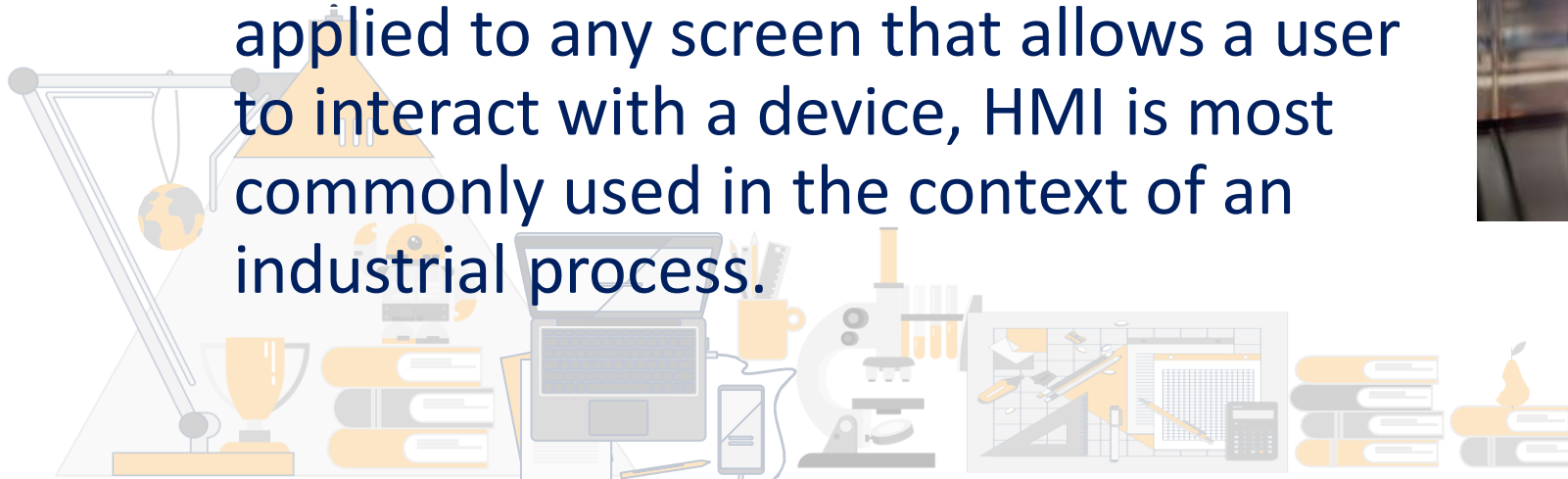
Human Machine Interface



Human Machine Interface (HMI)

Definition:

- A Human-Machine Interface (HMI) is a **user interface or dashboard** that connects a person to a **machine, system, or device**.
- While the term can technically be applied to any screen that allows a user to interact with a device, HMI is most commonly used in the context of an industrial process.



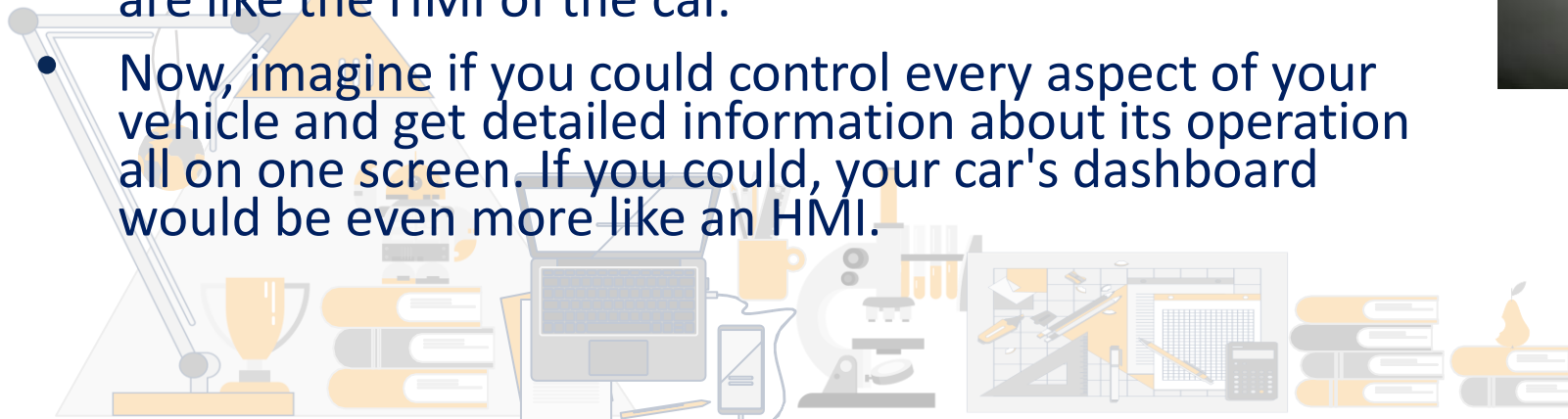
Human Machine Interface (HMI)

- **Basic HMI:** built-in screens on machines, computer monitors, and tablets.
- **Purpose:** to provide insight into mechanical performance and progress (regardless of their format or which term you use to refer to them).
- **Example:** a plant-floor operator might use an HMI to check and control the temperature of an industrial water tank, or to see if a certain pump in the facility is currently running.
- Similar to how you would interact with your air-conditioning system to check and control the temperature in your house.



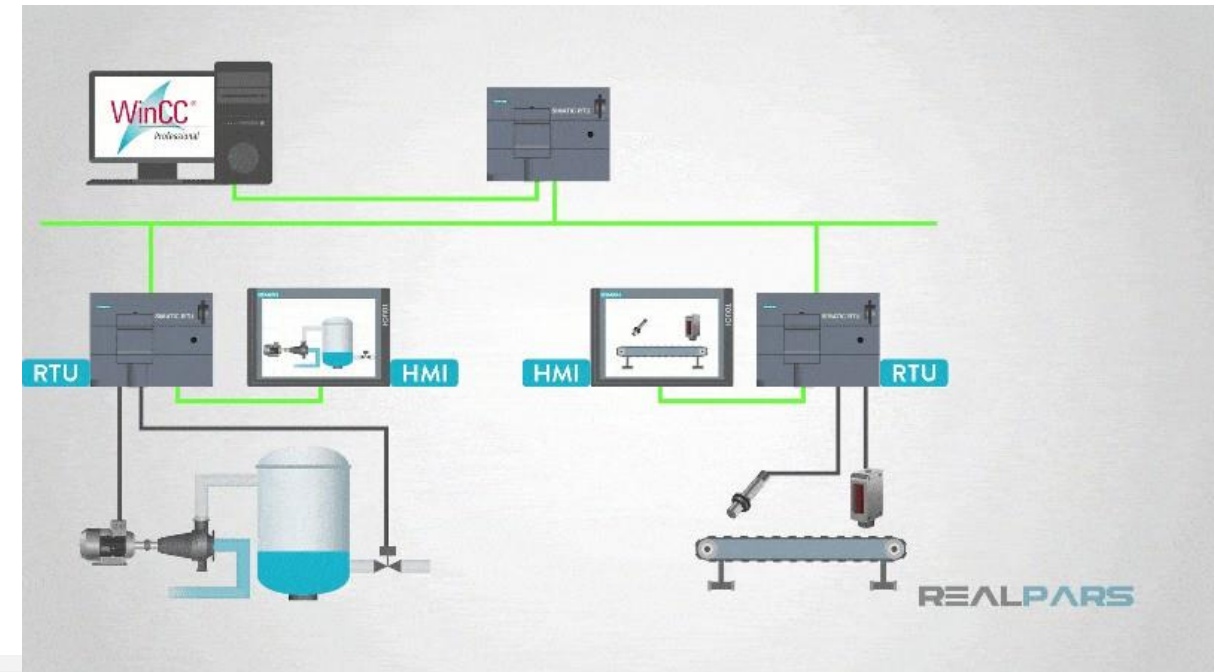
HMI explained

- Take the example of a **car**. A car is a complex machine. The driver can control the engine, steering, lights, air conditioning, stereo and various other elements.
- You don't have to interact directly with each of these elements, though, to control them and get information about their operation.
- Your speed is displayed on your speedometer. You can control your stereo, lights and air conditioning with knobs and buttons or perhaps a touchscreen. To control the engine, you use the gas pedal, and to turn, you use the steering wheel. These controls and feedback instruments are like the HMI of the car.
- Now, imagine if you could control every aspect of your vehicle and get detailed information about its operation all on one screen. If you could, your car's dashboard would be even more like an HMI.



Who Uses HMIs? (industry)

- HMI technology is used by **almost all industrial organizations**, as well as a wide range of other companies, to interact with their machines and optimize their industrial processes.
- Industries using HMI include:
 - Energy
 - Food and beverage
 - Manufacturing
 - Oil and gas
 - Power
 - Recycling
 - Transportation
 - Water and waste-water
 - And many more



Who Uses HMIs? (professions)

HMIs are used by professionals:

- The most common roles that interact with HMIs are **operators**, system **integrators**, and engineers, particularly control system **engineers**.
- HMIs are essential resources for these professionals, who use them to review and monitor processes, diagnose problems, and visualize data.



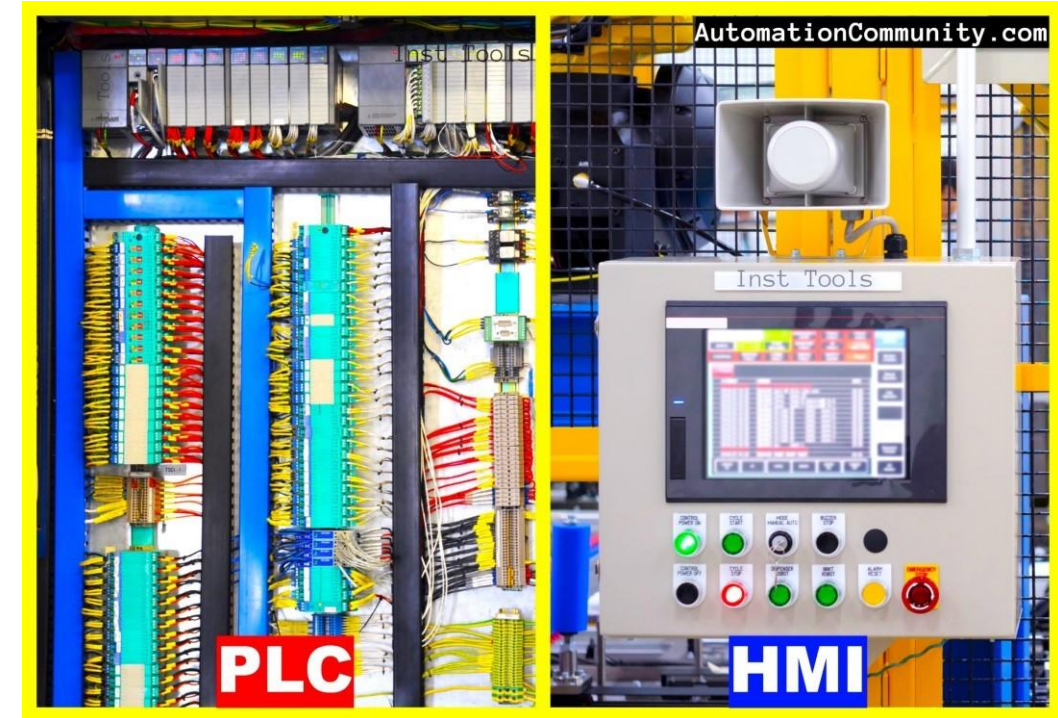
HMIs' purpose

- HMIs are similar in some ways to Graphical User Interfaces (GUI) but they are **not** synonymous.
- GUIs are often leveraged within HMIs for visualization capabilities.
- In industrial settings, HMIs can be used to:
 - Visually display data
 - Track production time, trends, and tags
 - Oversee KPIs (Key Performance Indicators)
 - Monitor machine inputs and outputs
 - And more



Uses of HMI in industry

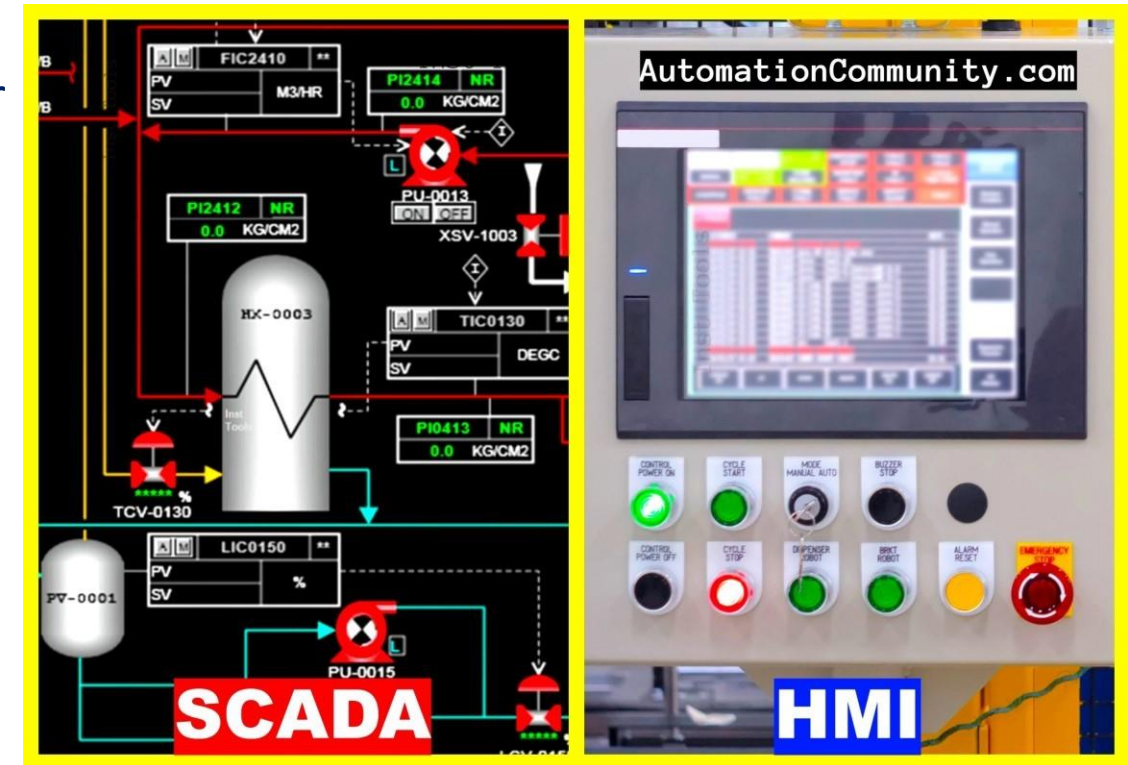
- HMIs **communicate with PLCs** (Programmable Logic Controllers) and **input/output sensors** to get and display information for users to view.
- Used for a **single function** (monitoring and tracking), or for performing **more sophisticated operations** (switching machines off or increasing production speed).
- HMIs are used **to optimize an industrial process** by digitizing and centralizing data for a viewer. Important information is displayed in graphs, charts, or digital dashboards. View and manage alarms, and connect with SCADA, ERP, and other systems, **all through one console**.
- No need to walk the floor constantly to review mechanical progress and record it on a piece of paper or a whiteboard.
- PLCs communicate real-time information straight to an HMI display, eliminating problems caused by lack of information or human error.



<https://automationcommunity.com/>

HMI and SCADA

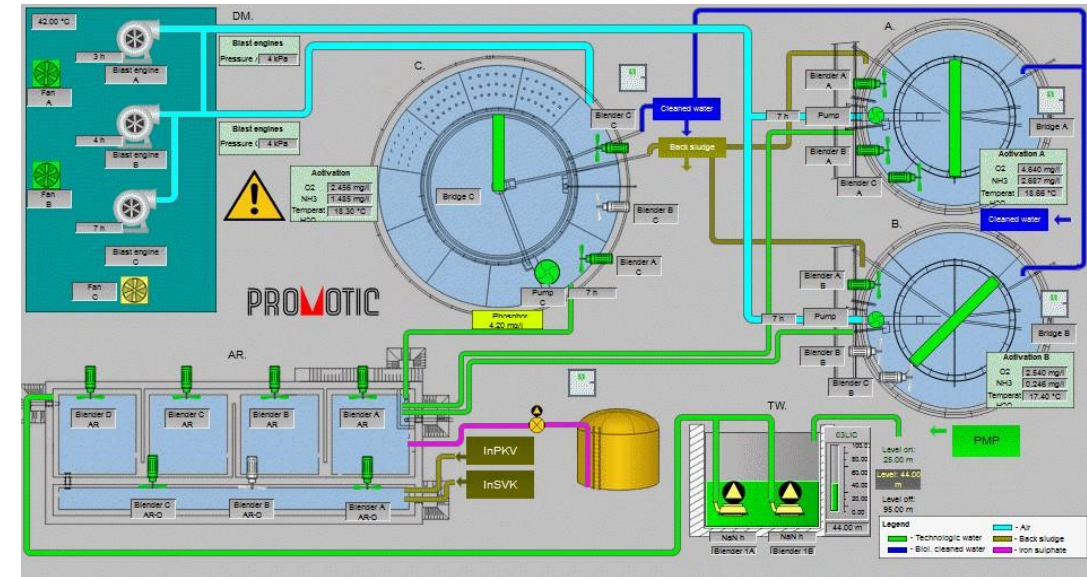
- HMI and SCADA (Supervisory Control And Data Acquisition) are sometimes **confused** because of their similarities and the fact that they work together.
- In fact, **an HMI is often a part of a SCADA system.**
- A SCADA system is used for controlling large systems, such as an entire plant or site. It is a combination of many other systems including PLCs, sensors and Remote Terminal Units (RTUs).
- A SCADA system is what collects and records data. It can also control equipment operations, sometimes automatically.
- An HMI, on the other hand, is the interface that someone uses to interact with a SCADA system and other systems and equipment.



<https://automationcommunity.com/>

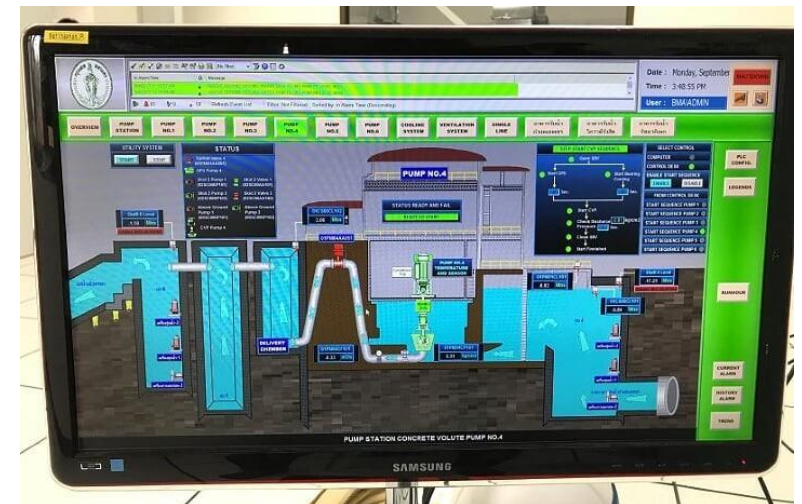
HMI and SCADA

- They are both essential elements of the larger industrial control system.
- While the **SCADA** collects and stores the data, the **HMI** enables users to interact with the equipment and manage it by providing a user-friendly dashboard.
- They are **both necessary**. Without SCADA, an HMI would not have any information to show or be able to control equipment. Without an HMI system, users would not be able to see the data the SCADA system collects or tell it how to control equipment.
- SCADA and HMI are part of the same larger system. SCADA works in the background, while HMI is typically the only element that users interact with. This is why users often reference them together.



What is the Difference Between HMI and SCADA?

- **HMI**s are focused on visually conveying information to help the user supervise an industrial process.
- **SCADA** systems have a greater capacity for data collection and control-system operation.
- Unlike SCADA systems, HMIs do not collect and record information or connect to databases.
- Rather, HMI provides an effective communication tool that functions as part of, or alongside, a SCADA system.

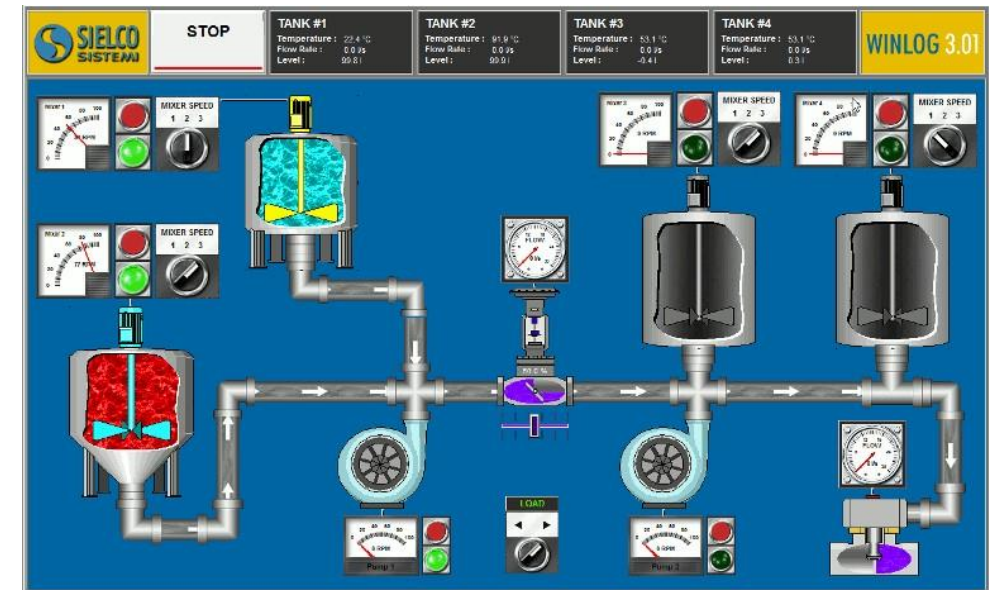


HMI sees use across a wide range of industries, being common in:

- **Manufacturing** various types of goods (automobiles, food and beverage, pharmaceuticals).
- **Industries** such as energy, water, wastewater, buildings and transportation.
- System integrators, operators and engineers use HMIs to control machines, vehicles, plants or buildings.

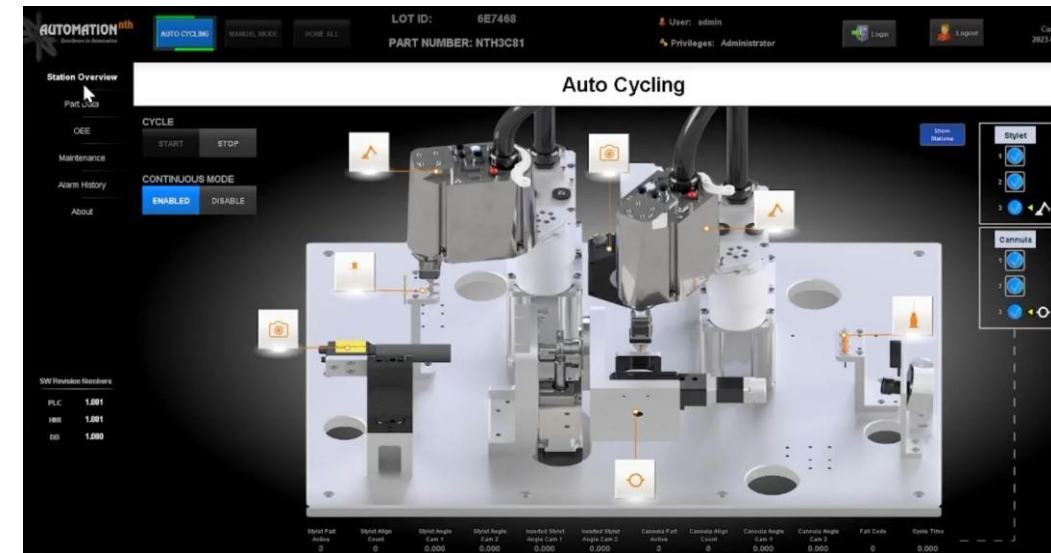
Sophistication of the HMI varies according to :

- the **complexity** of the machine or system
- how you **plan to use** the HMI:
 - HMI for one function, such as monitoring a piece of machinery, or
 - for multiple purposes, including monitoring plant operations and controlling equipment.



HMIs provide a number of **benefits** to today's industrial organizations, including:

- **Enhanced visibility:** A high-performance HMI allows to see how equipment or facility is performing from a single dashboard. One can even view this dashboard remotely. Improves productivity over time and respond to alerts more quickly.
- **Increased efficiency:** constant access to real-time data. Monitor production and adjust to changing demand in real time. Data visualization (combined with data analysis technologies) identifies areas where you can improve the efficiency of operations.



HMIs' benefits (2/2)

- **Decreased downtime:** alerts on a central dashboard, quick respond to problems, reducing downtime. Equipment performance data identify signs of future mechanical problems and address them before they escalate into issues that may cause significant downtime.
- **Improved usability:** easier for users to view and understand data and control equipment. Present data using graphs, charts and other visualizations, easy for users to interpret it quickly. Customization of dashboards to fit needs and preferences.
- **Unified system:** control all equipment using the same platform, easier for operators to learn how to control equipment. View all data in one location, clear overview of the entire facility. All users get updates in real time.



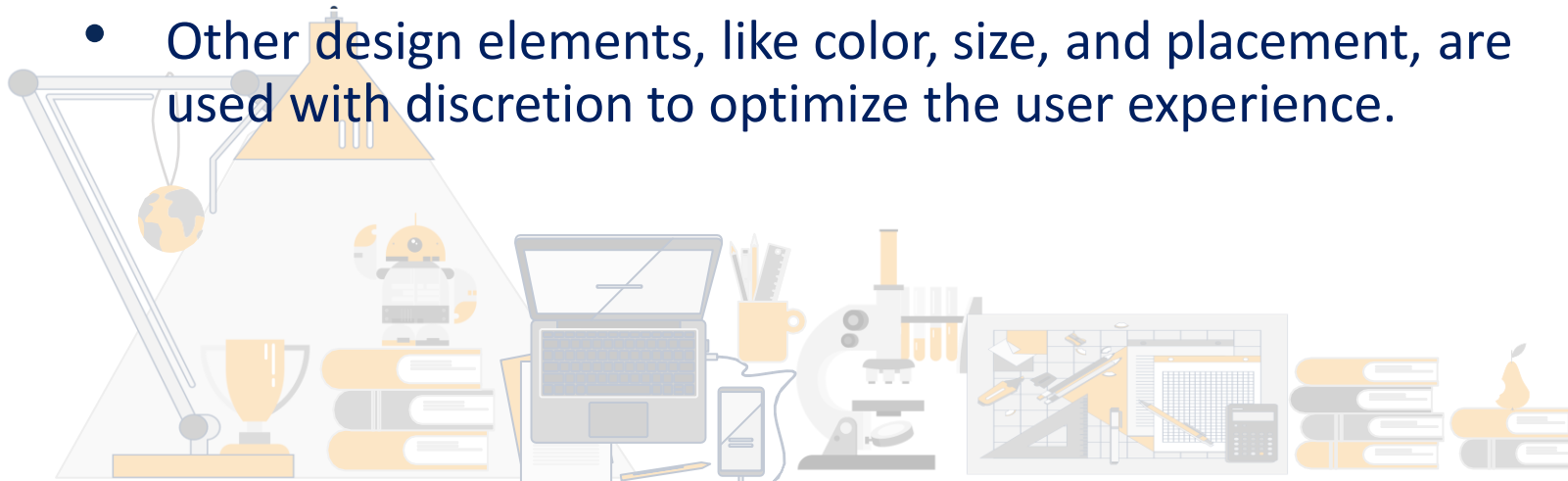
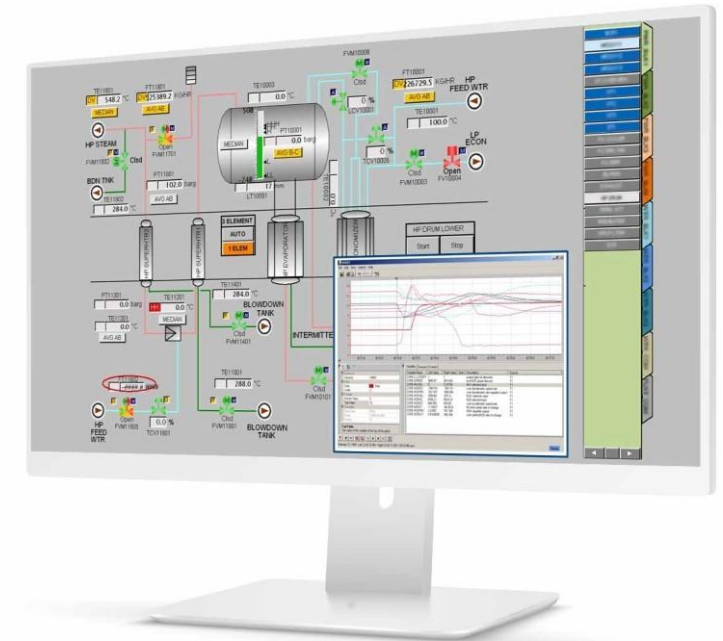
1.Touch Screens and Mobile Devices

- Touch screens and mobile devices are two HMI examples of technological advances that have emerged with the advent of smartphones.
- Instead of buttons and switches, modernized HMIs allow operators to tap or touch the physical screen to access controls.
- Touch screens are especially important when used with mobile HMI, which is either deployed through web-based HMI/SCADA or via an application.
- Mobile HMI offers a variety of advantages to operators, including instant access to HMI information and remote monitoring.



2. High-Performance HMIs

- **High-performance HMI**, a method of HMI design that helps ensure fast, effective interaction.
- Attention to the most necessary or critical indicators on the interface: see and respond to problems more efficiently, make better-informed decisions.
- Indicators on high-performance HMIs: simple, clean, and purposely cleared of any extraneous graphics or controls.
- Other design elements, like color, size, and placement, are used with discretion to optimize the user experience.



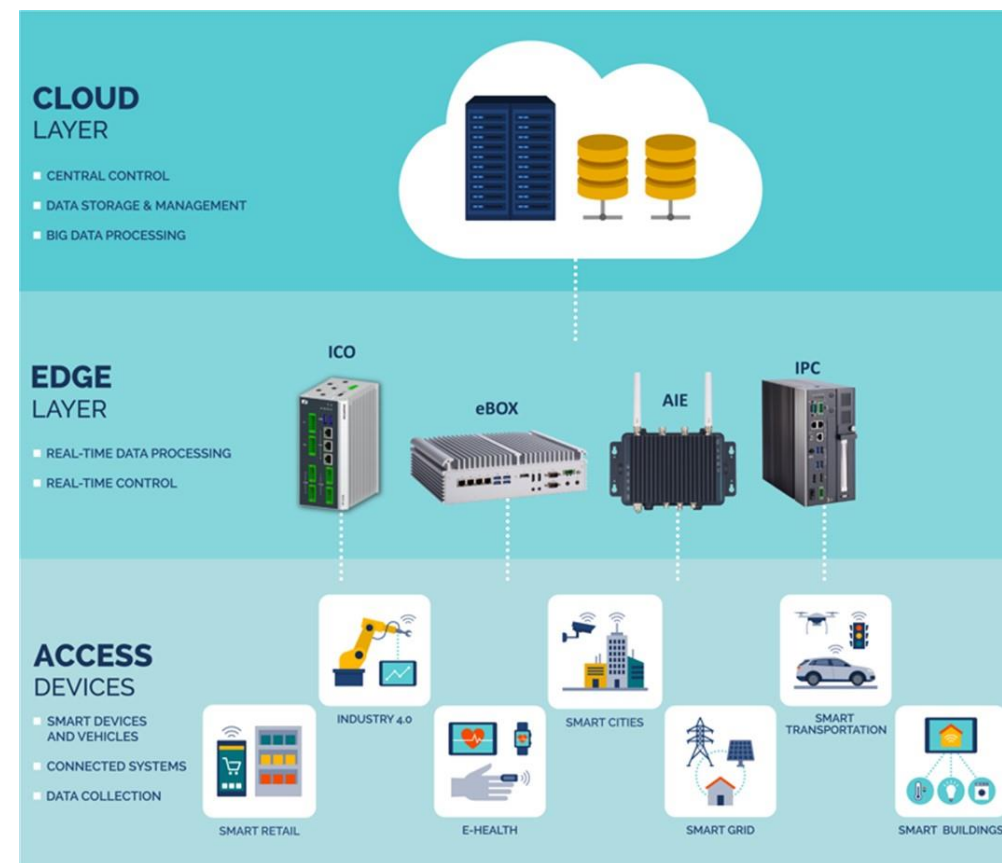
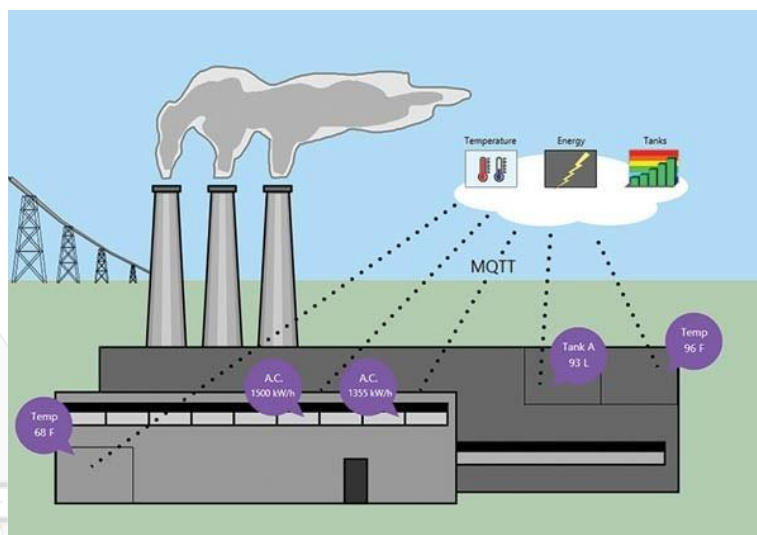
3. Remote Monitoring

- Mobile-friendly remote monitoring allows greater flexibility and accessibility for operators and managers.
- For example: with this feature, an offsite control system engineer can confirm the temperature of a warehouse on a portable device, eliminating the need for onsite supervision after working hours.
- Checking in on a process on a factory floor while being miles away from the facility is now like ordinary.



4. Edge-of-Network and Cloud HMIs

- Edge-of-network HMIs are also in high demand because they allow operators to access data and visualization from field devices.
- Additionally, it is becoming more common to send data from local HMIs to the cloud, where it can be accessed and analyzed remotely, while keeping control capabilities local.

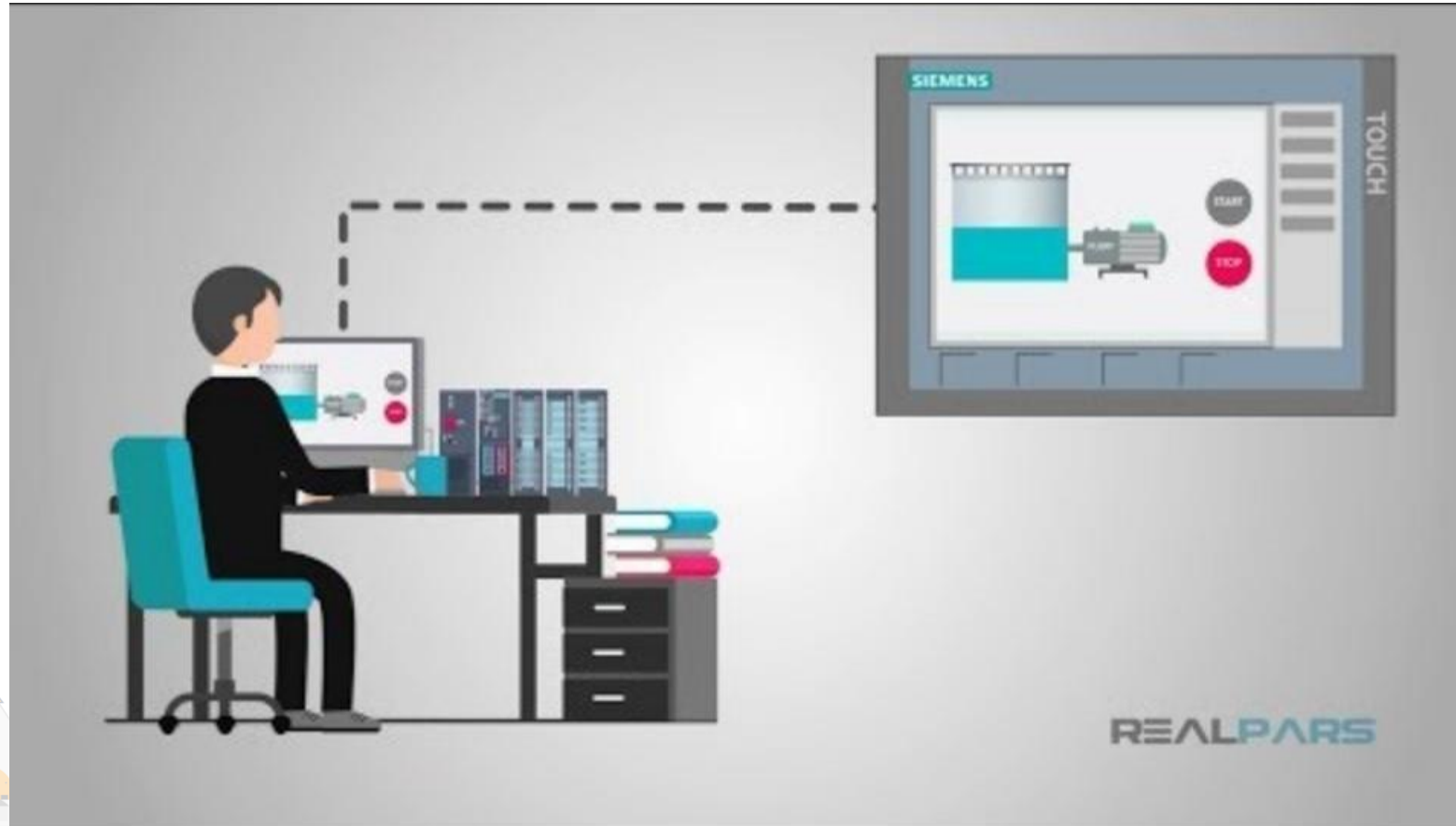


Future of HMI

- Data takes on a more prominent role in industrial processes.
- High-performance HMIs.
- Companies increasingly use:
 - multi-touch screens, remote monitoring, cloud-based systems
 - advanced data analytics and artificial intelligence derive insights from data, communicate these insights to users via HMIs.
- Automation's central role in industrial processes: users can leverage HMIs to monitor automated activities and adjust them as needed.
- In the future, HMIs may also incorporate
 - augmented reality (AR), which overlays digital graphics on the real world, and
 - virtual reality (VR) technology, which immerses users in a digital world, to create more effective visuals for HMI users.



What is an HMI? (Video)



<https://www.youtube.com/watch?v=kujHQgK352o>

User Experience (UX)



User Experience

- **“A person's perceptions and responses that result from the use or anticipated use of a product, system or service.”**

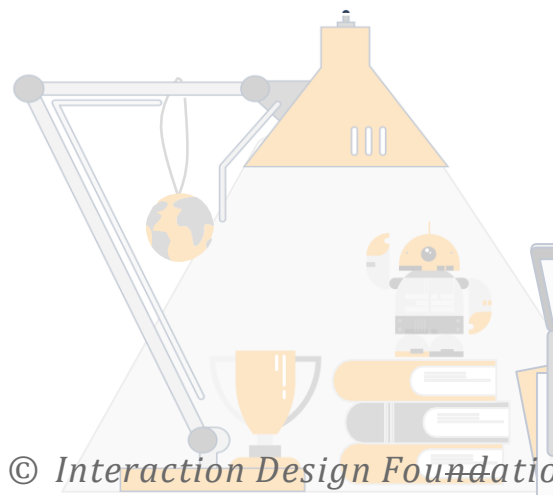
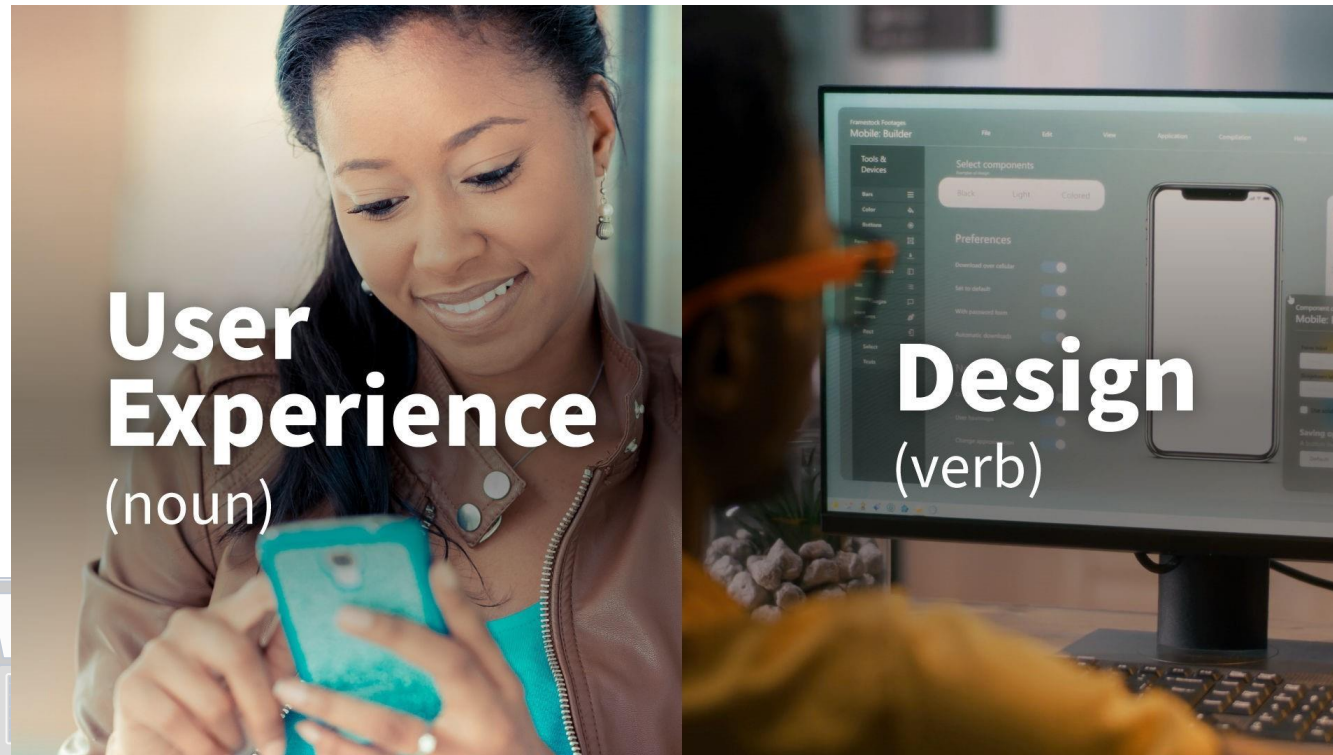
—ISO 9241-210, Ergonomics of human-system interaction—Part 210: Human-centered design for interactive systems

- **“One cannot design a user experience, only design for a user experience. In particular, one cannot design a sensual experience, but only create the design features that can evoke it.”**

—Jeff Johnson, Assistant Professor in the Computer Science Department of the University of San Francisco

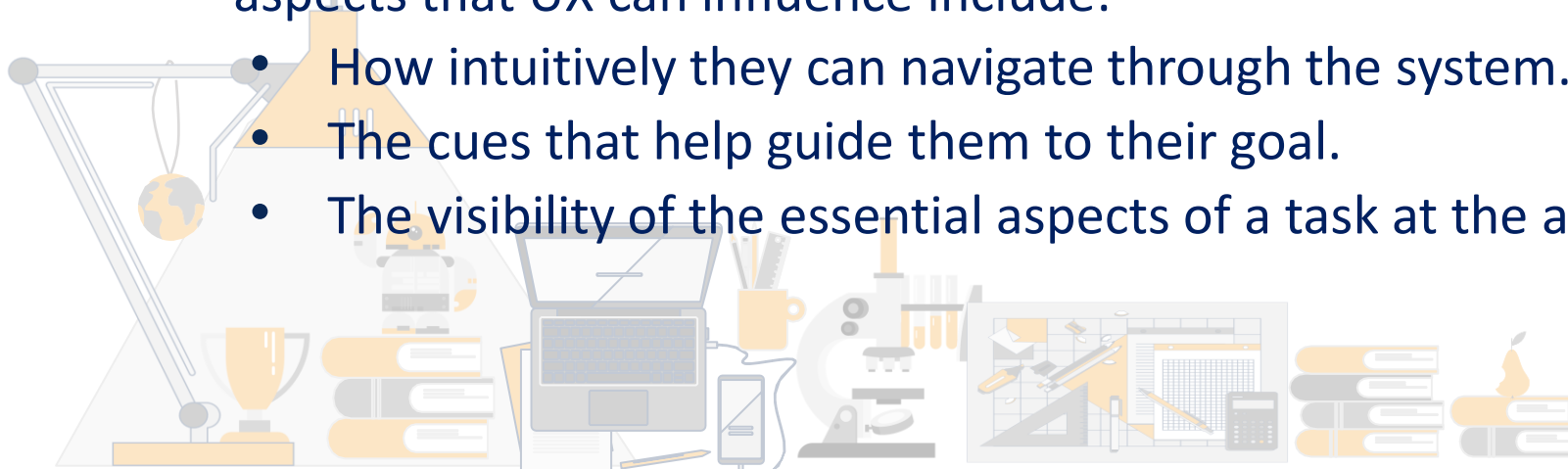
<https://www.interaction-design.org/literature/topics/ux-design>

- The simplest way to think about user experience design is as a **verb** and a **noun**. A UX designer designs (verb)—ideates, plans, changes—the things that affect the user experience (noun)—perceptions and responses to a system or service.

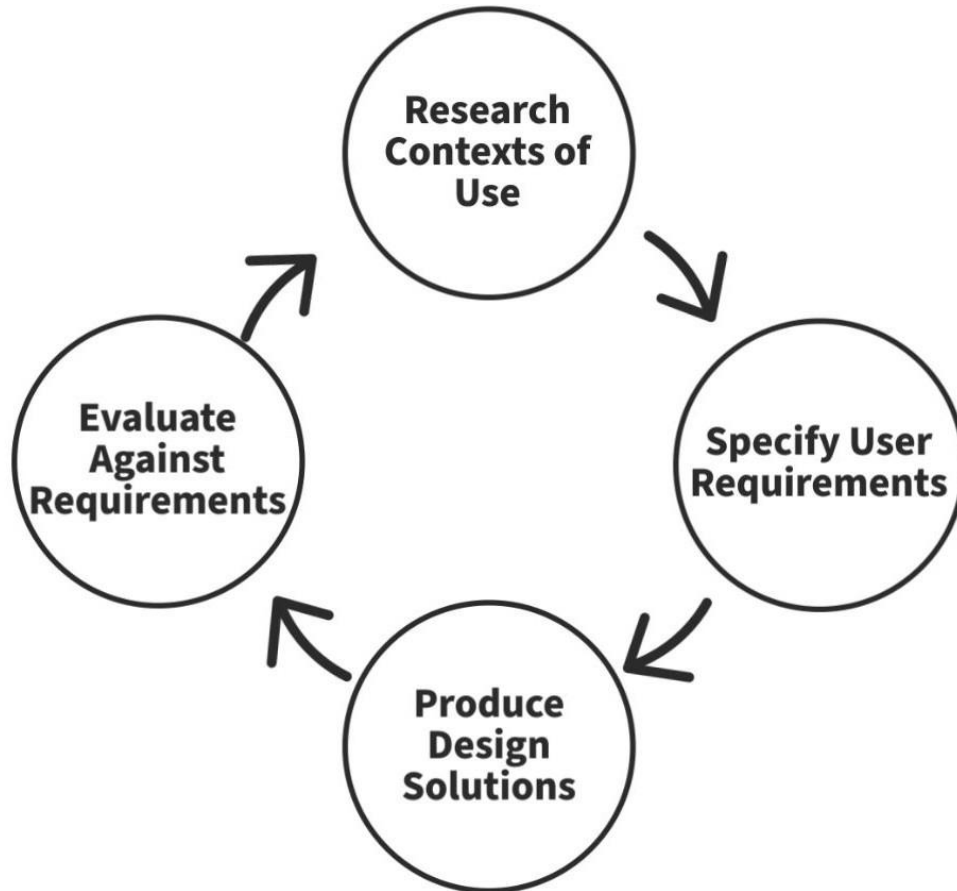


User Experience Basics

- Involves the design of the **entire process of acquiring and integrating** the product, including aspects of branding, design, usability and function.
- Focuses on having a **deep understanding of users**, what they need, what they value, their abilities, and their limitations.
- Aims to **improve the quality** of the user's interaction with and perceptions of the product and any related services.
- E.g., when a person uses a digital product, such as a computer application, a few aspects that UX can influence include:
 - How intuitively they can navigate through the system.
 - The cues that help guide them to their goal.
 - The visibility of the essential aspects of a task at the appropriate time.



User Experience (UX) design



- User-centered design is an iterative process. Starting point for all design and development is the understanding of the users and their context.
- UX designers use different tools for different tasks in the design process. For example:
 - Survey tools such as Typeform and Google Forms help with user research.
 - Whiteboarding applications such as Miro and Whimsical are useful for affinity diagramming, brainstorming and defining user flows.
 - Interface design and prototyping tools like Figma, Adobe XD, Sketch and Marvel help designers communicate their ideas to stakeholders and developers and conduct usability testing.

User Experience (UX) design

- UX statistics show that 88% of online shoppers say they wouldn't return to a website after having a bad user experience (*source: Amazon Web Services*).
- Clearly UX is not something to be ignored.
- User experience is most relevant when designing mobile apps, software, or website interfaces.
- A good UX design ensures that technology is intuitive and easy to use.

But what actually is user experience design?



Good User Experience (UX) design

- User Experience (UX) design is the **process** design teams use to create products that provide meaningful and relevant experiences to users.
- This involves the **design of the entire process** of acquiring and integrating the product, including aspects of branding, design, usability and function.
- “A person of average (or even below average) ability and experience can figure out how to use the thing to accomplish something without it being more trouble than it’s worth”. *Steve Krug, Author of ‘Don’t make me think’.*



Primary characteristics of UX design

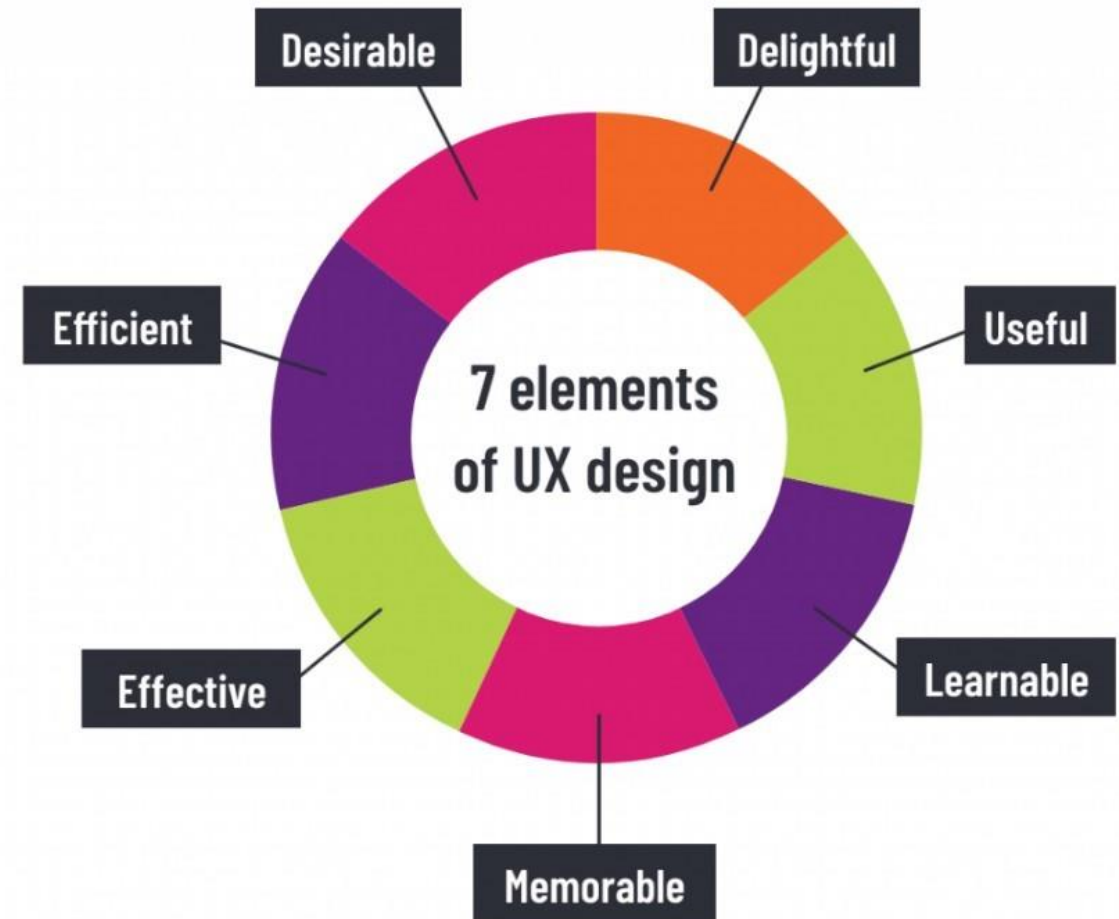
- **Usable:** The product is easy to use and navigate through
- **Useful:** The product should be able to fulfill the needs of the user (i.e., the users should be able to perform an intended action)
- **Desirable:** The product's interface should be neat and clean and interesting to look at
- **Findable:** The user should be able to locate features and pages they are looking for
- **Accessible:** The product should rank high on accessibility (i.e., the people with disabilities should be able to interact with the technology without much hassle)
- **Credible:** The users should believe in the business and everything it has to offer



7 Key Elements of UX

There are 7 key attributes of UX Design:

- Useful
- Learnable
- Memorable
- Effective
- Efficient
- Desirable
- Delightful
- + Accessible



7 Key Elements of UX

1. USEFUL: Does it do something people need done?

- The product, website or app needs to have a purpose for the target audience. Otherwise, if it doesn't deliver benefits to the customer, why would they buy it?

2. LEARNABLE: Can people figure out how to use it?

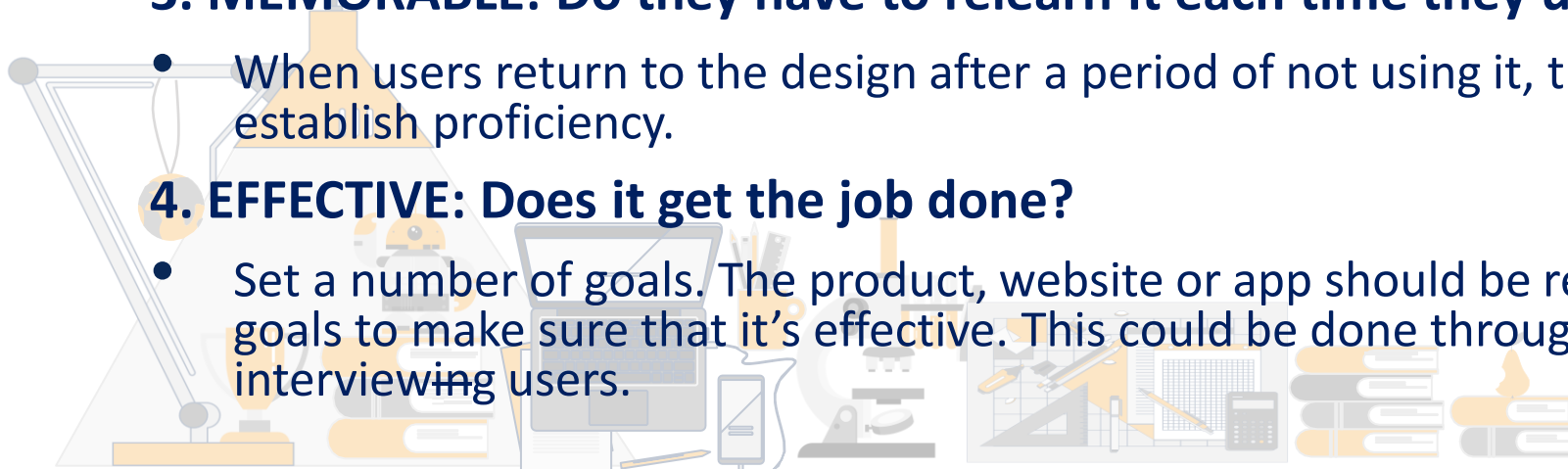
- It should be easy for users to accomplish basic tasks the first time they encounter the design. Already learned behaviour and pre-established ideas (e.g. the menu will be in the top right, the logo will be on the top left, settings will be marked by a cog icon etc.). Provide a demo mode the first time users log in.

3. MEMORABLE: Do they have to relearn it each time they use it?

- When users return to the design after a period of not using it, they should be able to easily re-establish proficiency.

4. EFFECTIVE: Does it get the job done?

- Set a number of goals. The product, website or app should be regularly tested against these goals to make sure that it's effective. This could be done through analytics, a survey or by interviewing users.



7 Key Elements of UX

5. EFFICIENT: Does it get the job done with a reasonable amount of time and effort?

- To increase competitiveness, refine the product's user experience. Using A/B testing (compare 2 versions of the product/app/website with just one varying element) helps pinpoint changes to make user experience more efficient.

6. DESIRABLE: Do people want it?

- Difficult to define exactly what makes a product desirable as it's so intangible. The 'desirability factor' often has to do with the company's marketing pitch – the image, brand, reputation as well as the emotional response it provokes in the user.

7. DELIGHTFUL: Is using it enjoyable, or even fun?

- Successful products usually have a little spark of fun and delight that excites the user and make them want to shout about it to their friends. How smooth the process of using it is, how well it delivers on its promises, or other features.

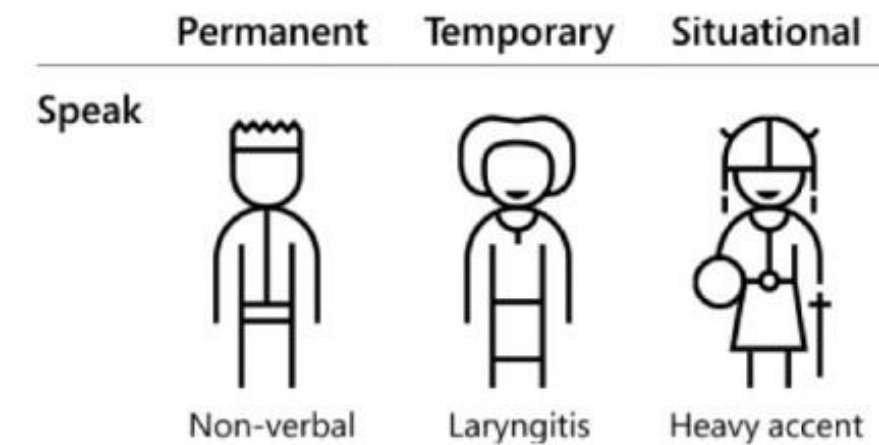
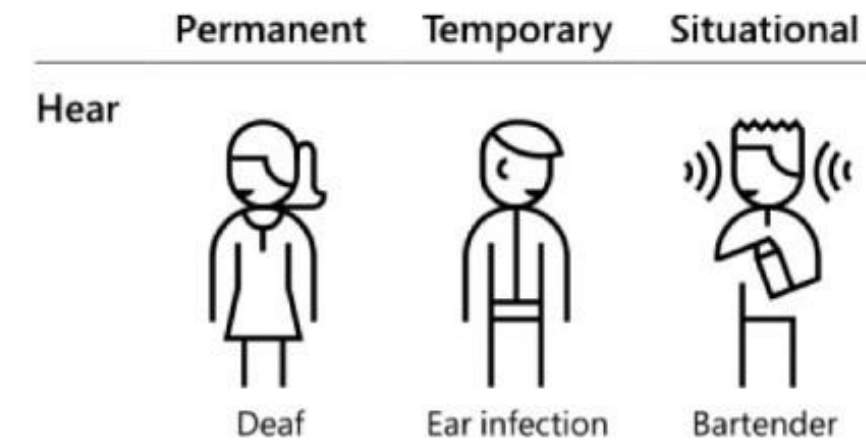
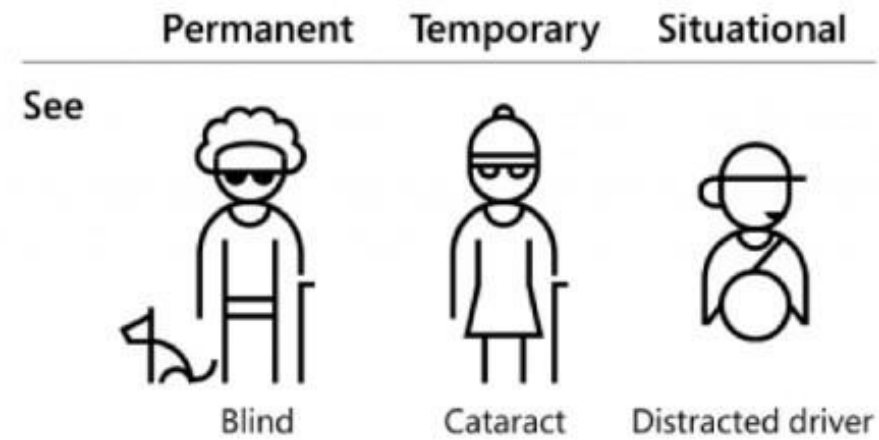
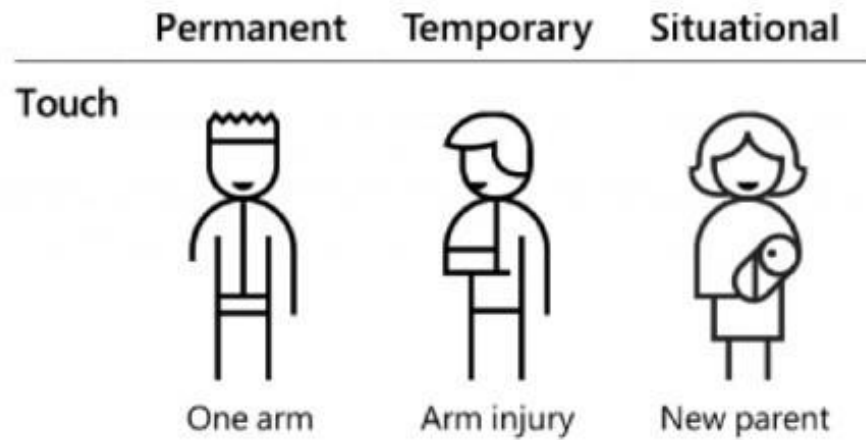


+1 Key Element of UX

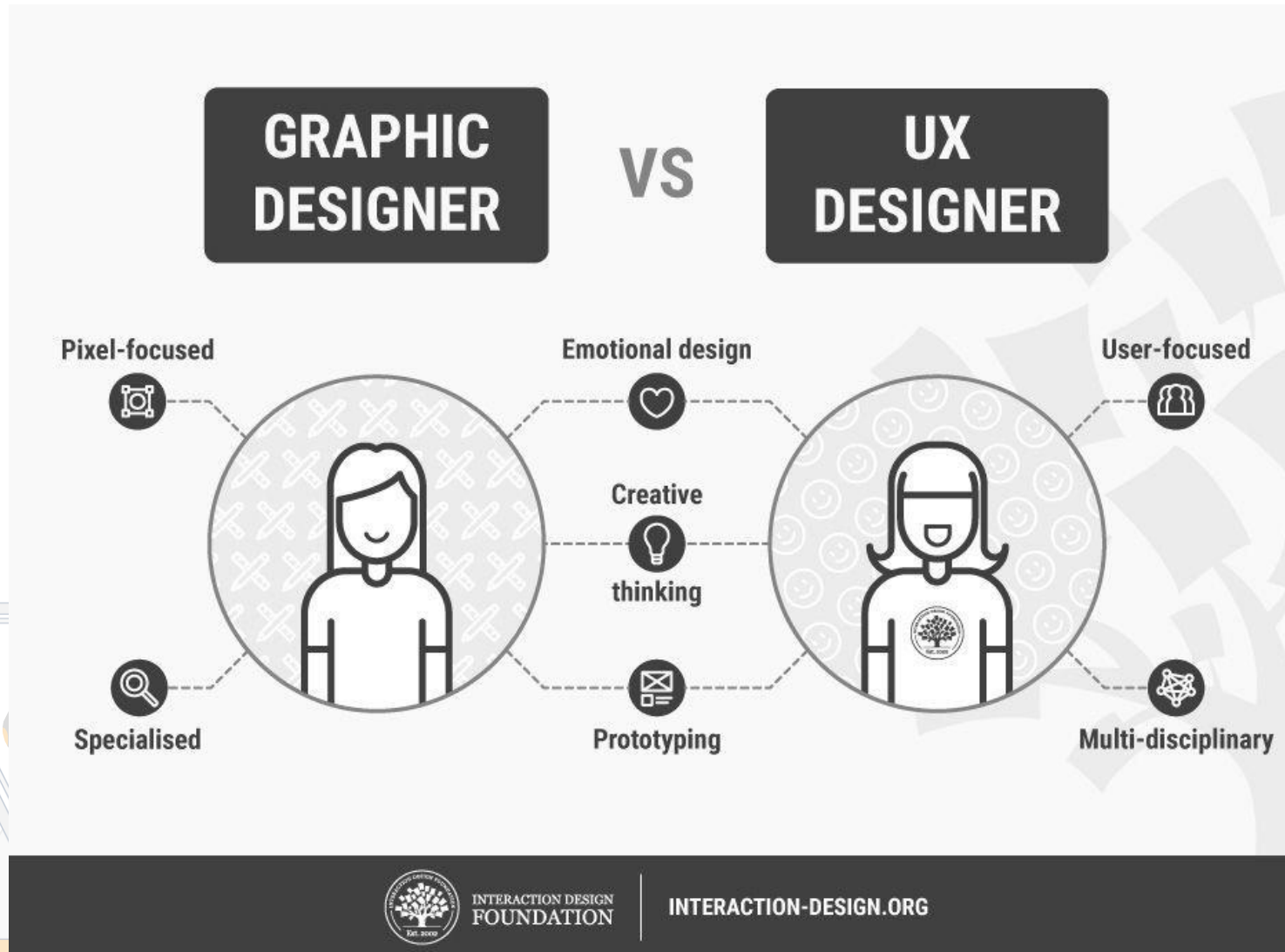
+ ACCESSIBLE

- Making a product, app or website accessible means we don't just design for fully able-bodied users but consider those who are **sight, hearing, touch, motion or learning impaired**.
- Often companies will dismiss accessibility as 'not worth investing in' and that 'hardly any of our users are disabled'. This is far from the truth. 22% of the UK's population are disabled – that's more than one in five.
- Not only ethical sense to exclude these people but the more people that can access the product, the more potential customers there are.
- Accessibility in user experience:
 - not vision impaired but a good colour contrast could benefit anyone,
 - not motion impaired but voice control could benefit one while driving.



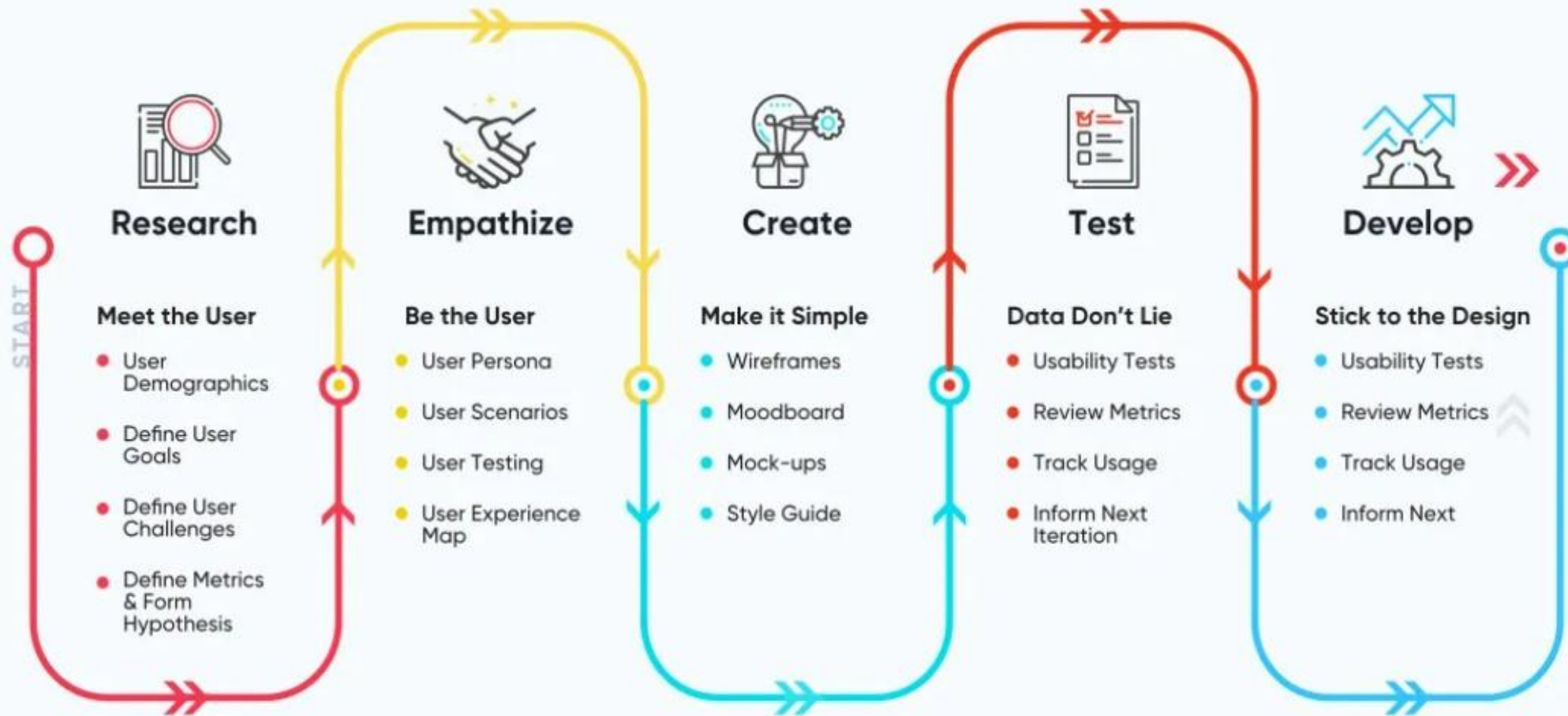


What is User Experience Design?



- User experience is most relevant when designing mobile apps, software, or website interfaces.
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User Experience Design Process



Latest UX Trends

- Password-Less Login
- UX Writing
- Anthropomorphic Animations
- Voice-Activated User Interface
- Personalization
- Virtual and Augmented Reality
- Videos
- Artificial Intelligence

How to Measure User Experience (UX)?

- Google's HEART framework is a good standard for measuring UX success. The five metrics used in the HEART framework include — happiness, engagement, adoption, retention, and task success.

	GOALS	SIGNALS	METRICS
HAPPINESS	User find the app helpful, fun, and easy to use	<ul style="list-style-type: none"> • Responding to surveys • Leaving 5-star ratings • Leaving user feedback 	<ul style="list-style-type: none"> • Net promote Score • Customer satisfaction rating • Number of 5-star reviews
ENGAGEMENT	User enjoy app content and keep engaging with it	<ul style="list-style-type: none"> • Spending more time in the app 	<ul style="list-style-type: none"> • Average session length • Average session frequency • Number of conversions
ADOPTION	New user see the value in the product or new feature	<ul style="list-style-type: none"> • Downloading, launching app • Signing up for an account • Using a new feature 	<ul style="list-style-type: none"> • Download rate • Registration rate • Feature adoption rate
RETENTION	Users keep coming back to the app to complete a key action	<ul style="list-style-type: none"> • Staying active in the app • Renewing a subscription • Making repeat purchases 	<ul style="list-style-type: none"> • Churn rate • Subscription renewal rate
TASK SUCCESS	Users complete their goal quickly and easily	<ul style="list-style-type: none"> • Finding and viewing content quickly • Completing tasks efficiently 	<ul style="list-style-type: none"> • Search exit rate • Crash rate

Google's HEART framework

a chart that depicts the goals of each of these UX metrics

Concluding UX design

- User experience (UX) design is all about how to make the users feel delighted with the product. UX design is so much more than just designing for a screen.
- For creating great UX design, it is essential to **understand user needs and desires** along with what delights and frustrates them.
- Businesses need to thoroughly understand UX before creating a digital experience that will lead to positive impressions.
- Concluding with the words of Don Norman, Director of Design Labs at the University of California —

“when the technology delivers basic needs, User experience dominates”.

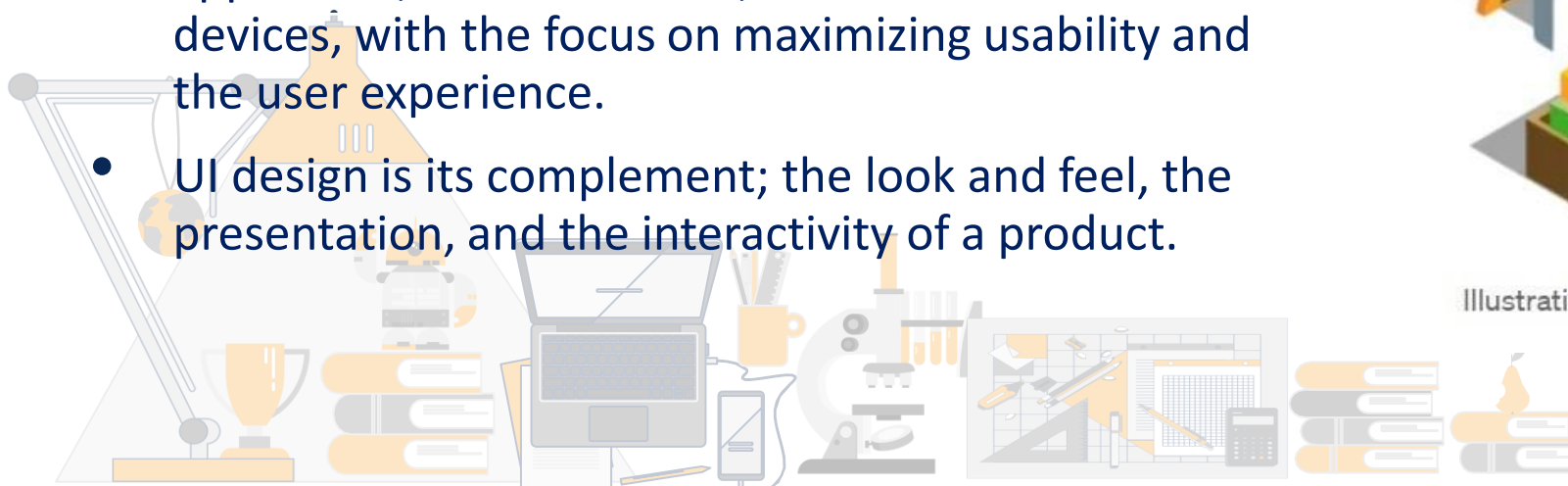


User Experience - User Interface

- **User Experience Design:** it's the process of creating a product that is easy to use, easy to interact with, and accessible for the users while putting their feelings first, based on a long-term and short-term scale.
- **User Interface Design:** is the design of user interfaces for machines and software, such as computers, home appliances, mobile devices, and other electronic devices, with the focus on maximizing usability and the user experience.
- UI design is its complement; the look and feel, the presentation, and the interactivity of a product.



Illustration credit by ABC building a career in UI/UX Internshala Blog



UI



UX

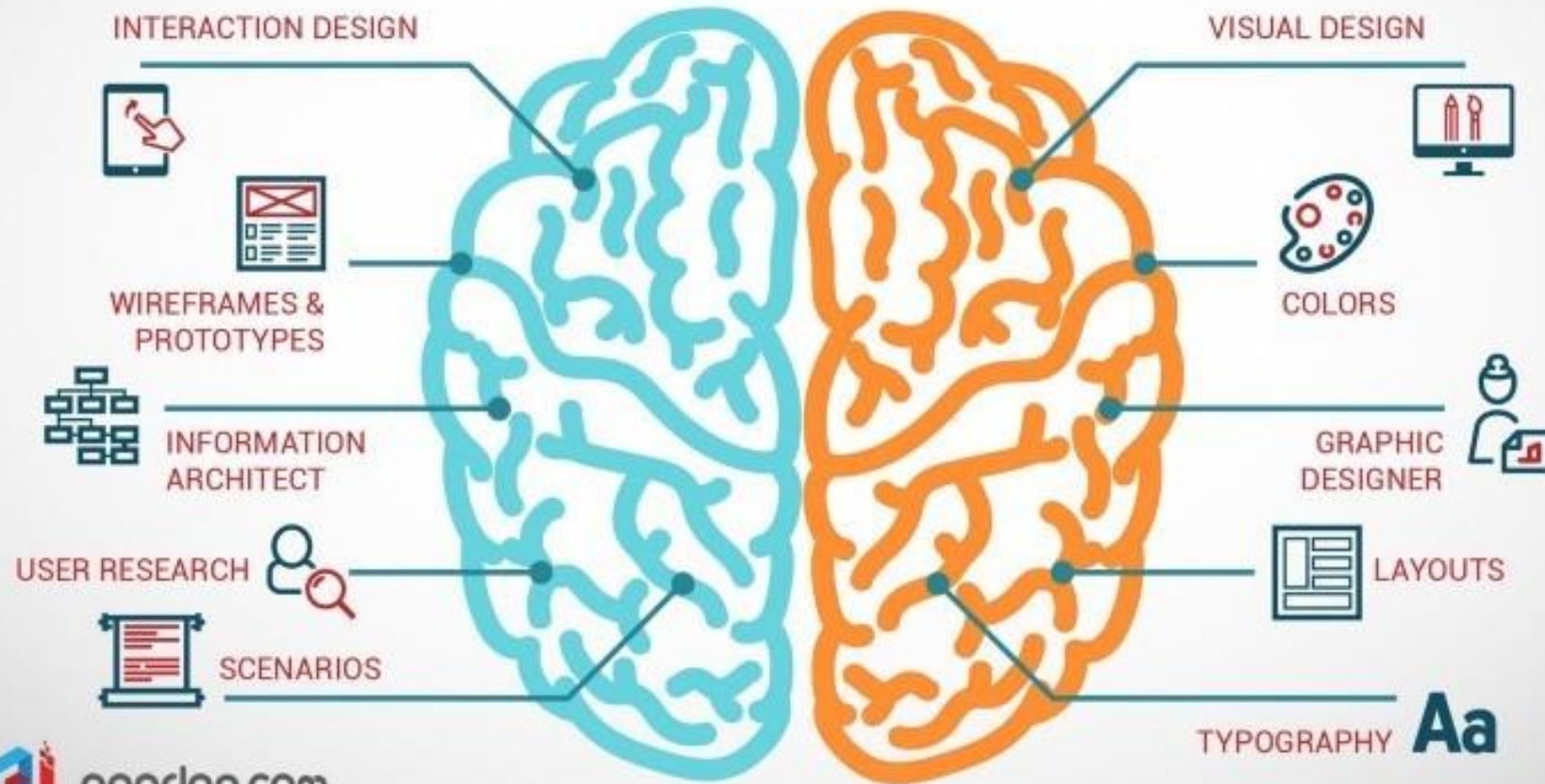
KNOWING THE DIFFERENCE BETWEEN

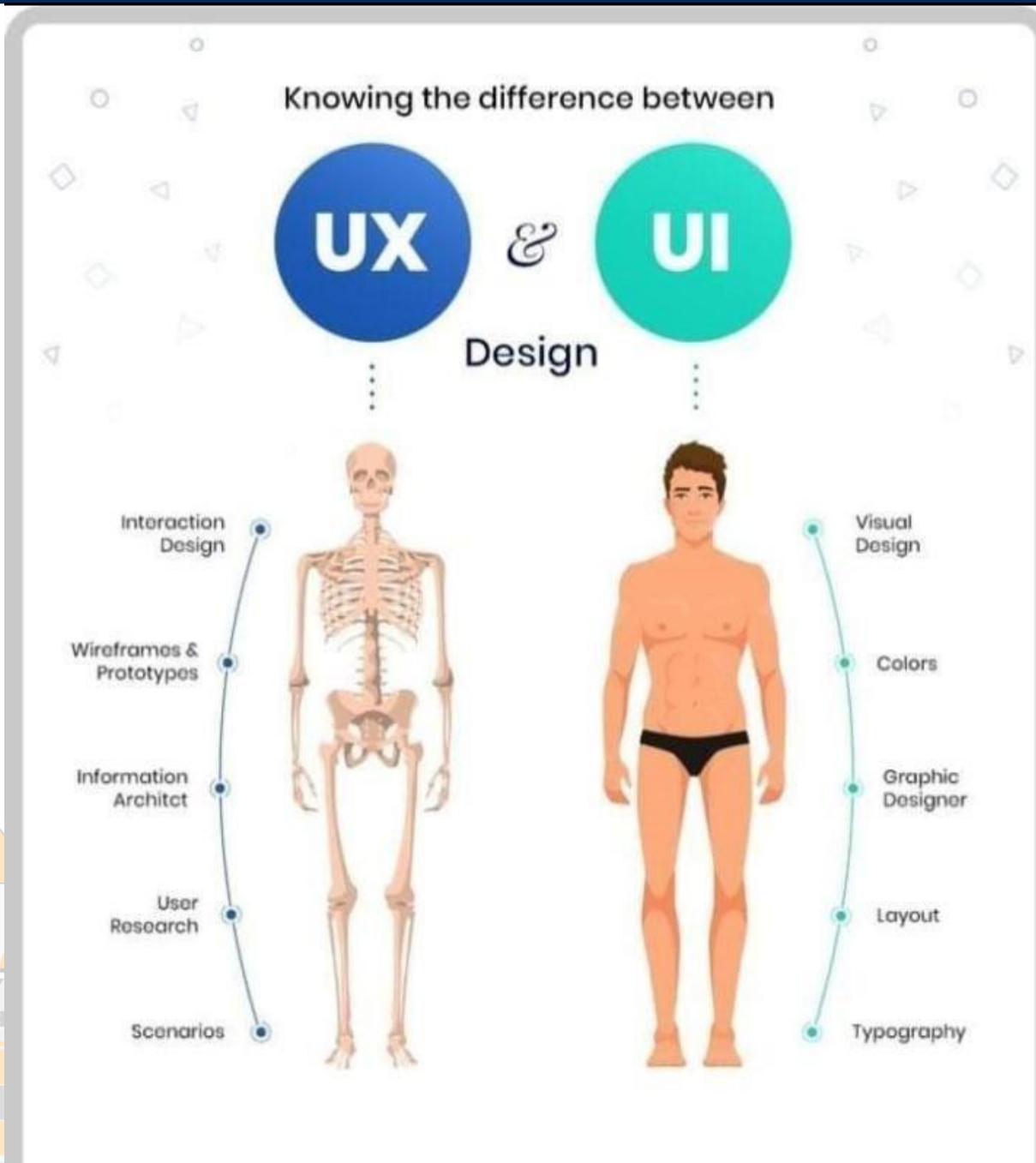
UX

&

UI

DESIGN





<https://aorthar.medium.com/>

User Research

- Primary Research
- Desktop Research
- Competitor Research

Research Analysis

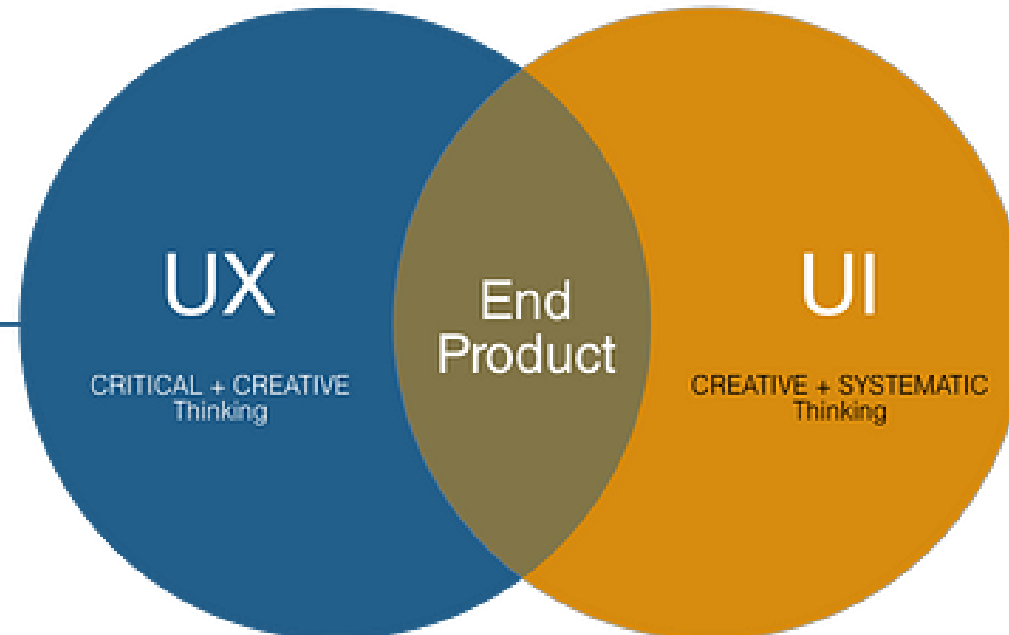
- Insights and Findings
- Customer Journey Maps
- Personas
- Empathy Maps
- Site Map
- Task flows
- User Flows

Design Ideation

- Idea sketches
- Wireframes
- Prototypes
- User Testing
- Design Iterations

Execution

- Co-ordination with stakeholders
- Transition to UI design
- Collabrate with UI designers



Interface Design

- Knowledge transfer on wireframes
- Look and Feel
- Branding and guidelines
- Moodboards
- Style Tiles
- Layout and Responsiveness
- User Testing

Design Specs

- UI Prototype
- Visual Design Documentation
- Developer's handout
- Icon and Illustration set
- Adaption to form factors and resolutions

Execution

- Assist developers
- Implementation Reviews
- Co-ordination with stakeholders
- Transition to final design

Inputs

- Identifying the need & Painpoint
- Collect data



UX Researcher

- Collected Data
- Research Analysis
- Competitor Study



UX Designer

- Wireframes
- Storyboards
- User feedback on ideas



UI Designer

Process

- User Interviews
- Secondary Research
- Competitor Analysis
- Research Analysis

- Understand end users: Drivers and riders
- Create persona for each and generate task flows and user flows
- Suggestion of ride and fare
- Use insights to create multiple ride sharing possibilities.
- Different people, different need: Car segments

- Create a visual identity which communicates the business model
- Easy way of navigation from one segment to another
- Find and see the car after booking
- Keep the relevant information visible at each step

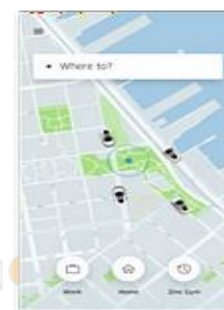
Outputs

- To reduce cost of transportation, ride sharing could be a viable solution.
- People can attach their own cars to be a part of this system and make extra income.

- A solution with an option to select car of your choice based on the distance and fare: introduced transparency
- Live tracking will help in estimating the wait time.
- Emergency button would be needed to ensure safety

- A strong brand which conveys the model of ride sharing
- Differentiate amongst various kinds of cars for easy selection
- Emergency button visible upfront, ease of access
- Monochrome design to focus on the key elements

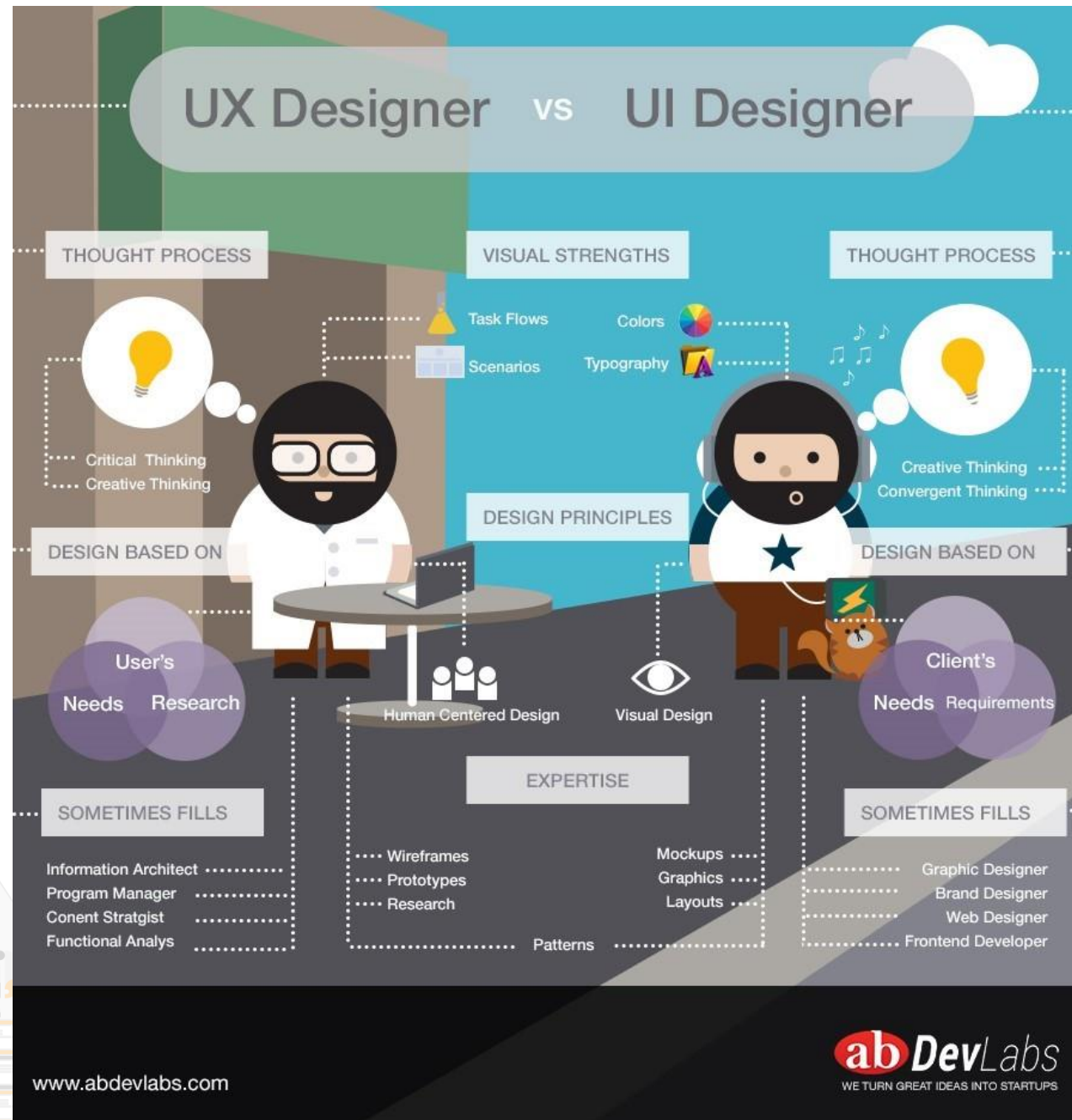
Deliverable







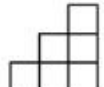

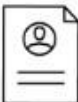
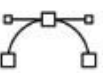
Basics of Mobile App Design

The Difference Between UI and UX





UX vs. UI designers

UX designer	UI designer
 Interaction designer	 Visual designer
 Charts the user pathway	 Chooses color and typography
 Plans information architecture	 Plans visual aesthetic
 Expert in wireframes, prototypes, and research	 Expert in mockups, graphics, and layouts



// TOP 10 JOB TITLES REQUIRING UX/UI SKILLS

01

User Experience
(UX) Designer

02

User Interface (UI)
Developer

03

User Interface (UX) / User
Experience (UX) Designer

04

User Interface (UI)
Designer

05

User Interface (UX) / User
Experience (UX) Developer

06

Software Development
Engineer

07

User Experience (UX)
Architect

08

Front End
Developer

09

Java Software
Developer

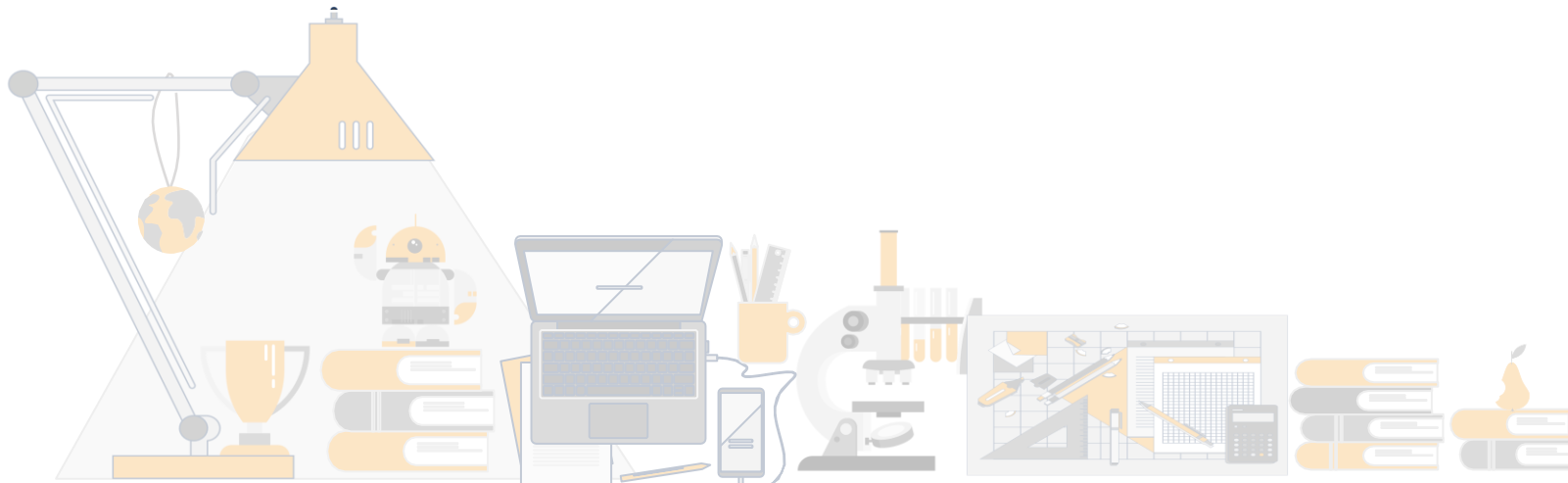
10

User Experience (UX)
Developer

Burning Glass Technologies, "UX and UI Designers: Skills You Need for a Good Career." (2019)

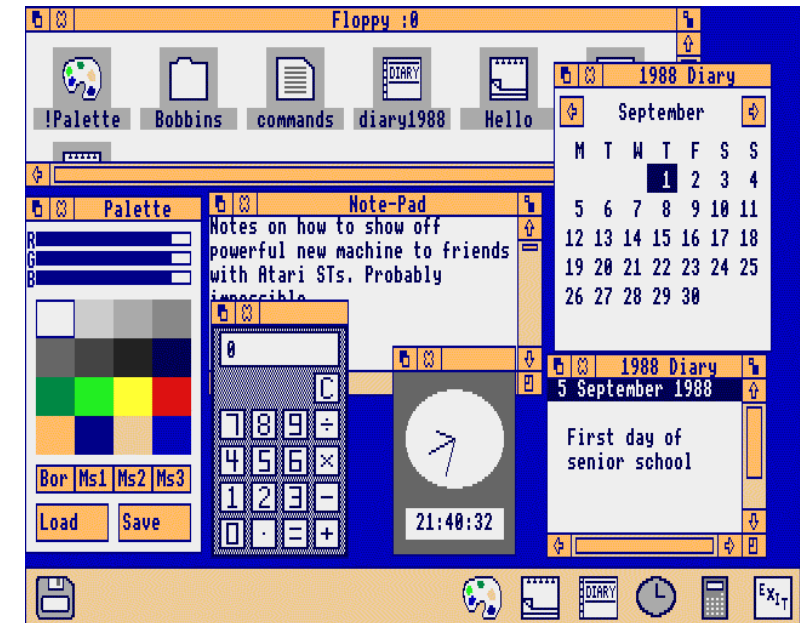
"<https://www.burning-glass.com/blog/dice-ux-and-ui-designers-skills-you-need-for-a-good-career/>"

Graphical User Interface



Graphical User Interface (GUI)

- A graphical user interface (GUI) is a digital interface in which a user interacts with graphical components such as icons, buttons, and menus.
- In a GUI, the visuals displayed in the user interface convey information relevant to the user, as well as actions that they can take.



```

Command Prompt
12/31/2020 05:33 PM 26,284 win98pro.htm
12/31/2020 05:33 PM 32,586 windows-10.htm
12/31/2020 05:33 PM 30,989 windows7.htm
12/31/2020 05:33 PM 30,165 windows8.htm
12/31/2020 05:33 PM 10,927 winipcfg.htm
12/31/2020 05:33 PM 23,545 winmeqa.htm
12/31/2020 05:33 PM 21,640 winntqa.htm
12/31/2020 05:33 PM 32,706 winxpqa.htm
12/31/2020 05:33 PM 62,952 wmic.htm
05/27/2010 03:53 PM 745 wp.jpg
12/31/2020 05:33 PM 23,328 wqanda.htm
12/31/2020 05:33 PM 22,675 xcophlp.htm
12/31/2020 05:33 PM 18,154 xdoseror.htm
12/31/2020 05:33 PM 15,148 xext.htm
12/31/2020 05:33 PM 12,703 yext.htm
12/31/2020 05:33 PM 11,784 youtube.htm
12/31/2020 05:33 PM 12,264 zext.htm
10/12/2020 12:09 PM <DIR> _notes
432 File(s) 7,679,571 bytes
38 Dir(s) 254,861,524,992 bytes free

C:\ch>echo computerhope.com
computerhope.com

C:\ch>
    
```

What Does GUI Stand For?

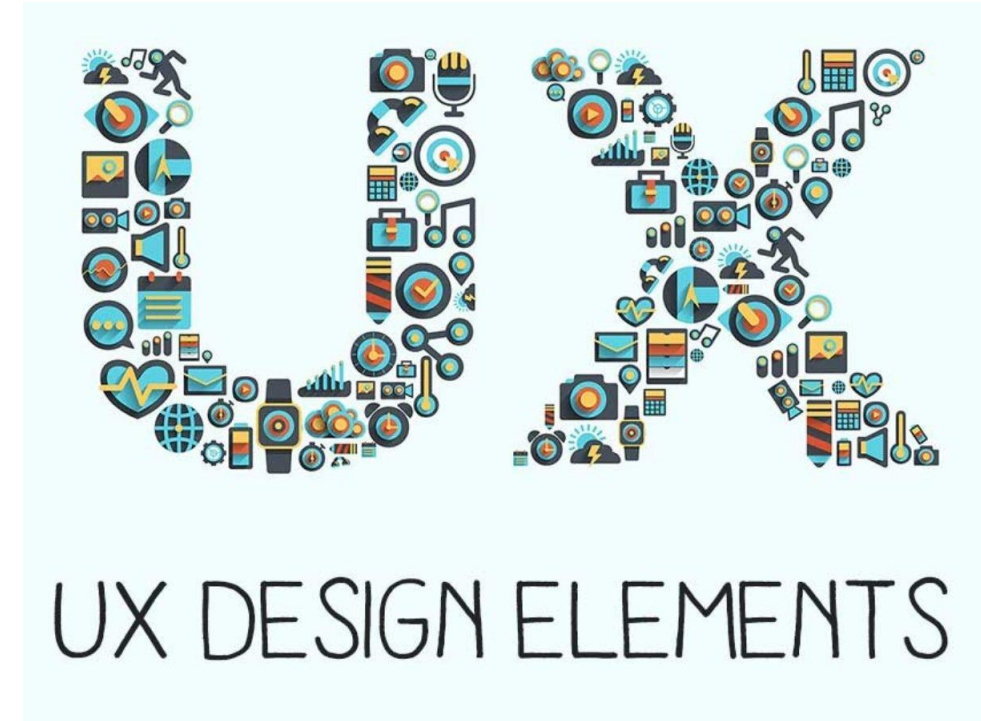
- A Graphical User Interface (GUI) is a type of user interface that allows you to interact with electronic devices through graphical icons and visual indicators, as opposed to text-based interfaces, typed command labels, or text navigation.
- If you've ever interacted with a computer, a smartphone, or a tablet, you've likely used a GUI (pronounced 'gooey').



Core concepts of GUI

Here's a list of common GUI elements – these are the objects that users interact with:

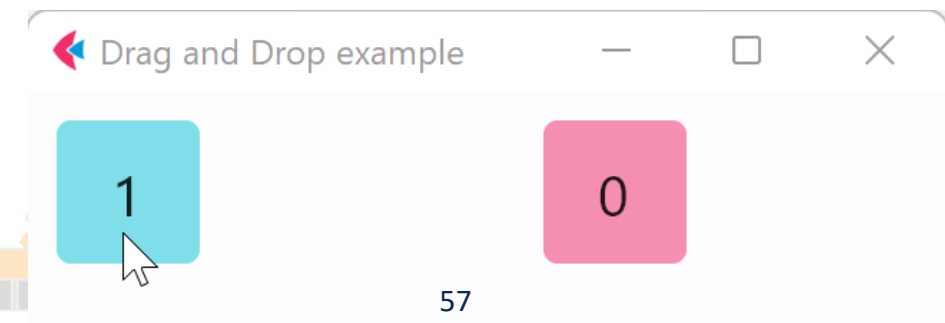
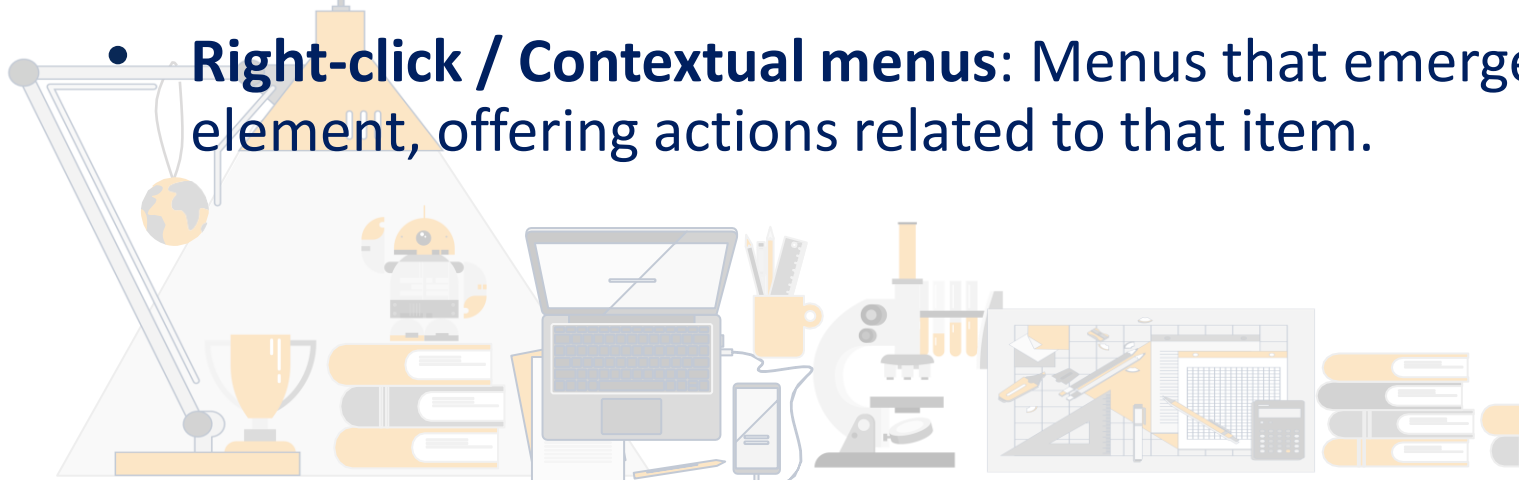
- **Windows:** Sections on the screen where applications or files are displayed.
- **Icons:** Graphical symbols representing a function, program, or file.
- **Menus:** Lists of commands or options.
- **Toolbars:** Groups of icons or buttons facilitating easy access to functions.
- **Buttons:** Graphical elements that trigger a specific action when clicked.
- **Form fields:** Spaces where users input data.
- **Lists:** Arrangements of selectable options.
- **Dialog boxes:** Pop-up windows providing information or asking for user input.
- **Pointers:** Cursors, typically controlled by a mouse, are used to interact with the GUI.



Interaction techniques

This is a list of ways that users commonly interact with GUI elements:

- **Direct manipulation:** Interacting with graphical elements as though they're physical objects.
- **Keyboard shortcuts:** Key combinations that perform certain functions.
- **Drag and drop:** Clicking an object and moving it to a different location on the interface.
- **Tooltips:** Informational text boxes appear when you hover over an element.
- **Right-click / Contextual menus:** Menus that emerge when right-clicking an element, offering actions related to that item.



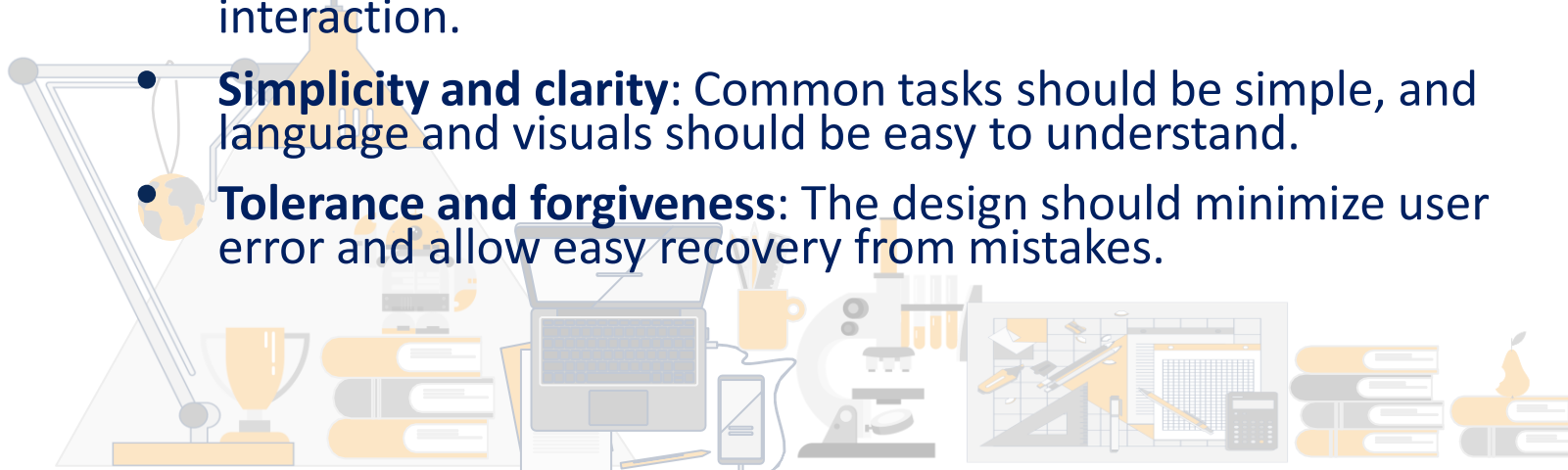
7 Principles of GUI Design

GUI design is a career in and of itself. It's equal parts science, art, and complexity. Principles of GUI design:

- **Visibility:** Options and functions should be easily identifiable.
- **Affordance:** The design of an object should hint at its function.
- **Feedback:** The interface should communicate actions, changes, or errors effectively.
- **Consistency:** Similar functions should have similar icons and behaviors.
- **User control:** Users should dictate the flow and pace of interaction.
- **Simplicity and clarity:** Common tasks should be simple, and language and visuals should be easy to understand.
- **Tolerance and forgiveness:** The design should minimize user error and allow easy recovery from mistakes.

7 Principles of GUI Design

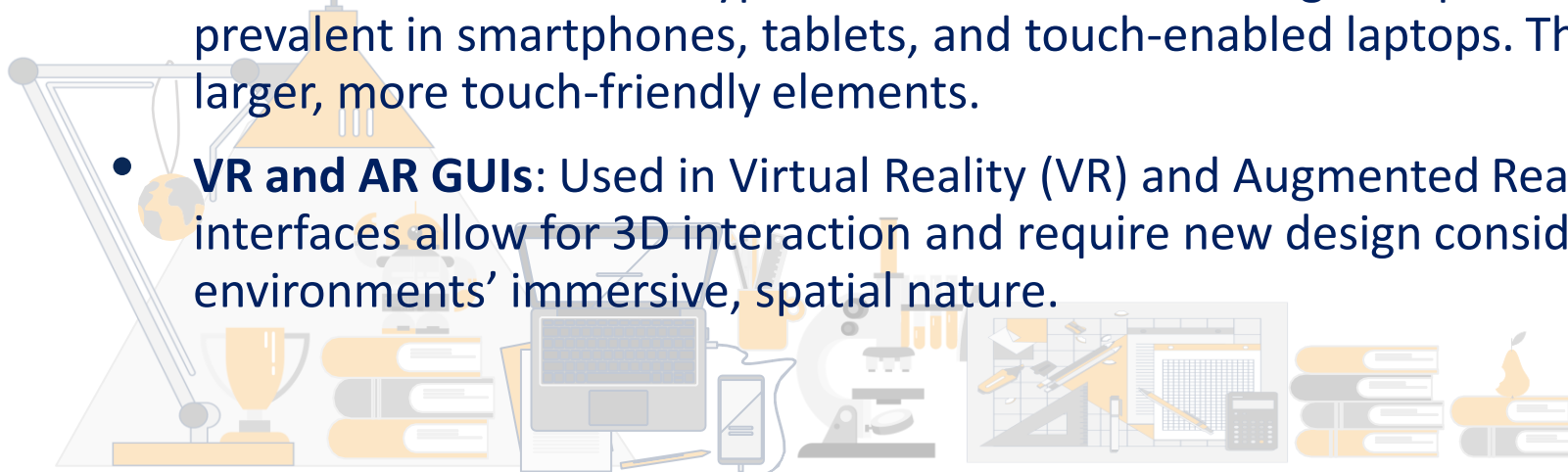
- 1 Visibility
- 2 Affordance
- 3 Feedback
- 4 Consistency
- 5 User control
- 6 Simplicity and clarity
- 7 Tolerance and forgiveness



Different types of GUIs

While all GUIs help users interact with technology, many different kinds exist. Here are a few common examples:

- **Desktop GUIs:** user interfaces designed for desktop computers. They feature elements like windows, icons, menus, and toolbars and are generally controlled by a mouse and keyboard.
- **Web GUIs:** designed for websites and web applications. They're usually created using technologies like HTML, CSS, and JavaScript and are accessed through a web browser.
- **Mobile GUIs:** Tailored for mobile devices like smartphones and tablets, Small screen sizes and touch interaction. Typically built with mobile-specific development frameworks.
- **Touchscreen GUIs:** This type refers to interfaces designed specifically for touch input, prevalent in smartphones, tablets, and touch-enabled laptops. These interfaces often feature larger, more touch-friendly elements.
- **VR and AR GUIs:** Used in Virtual Reality (VR) and Augmented Reality (AR) technologies, these interfaces allow for 3D interaction and require new design considerations to account for these environments' immersive, spatial nature.



Other user interfaces to know

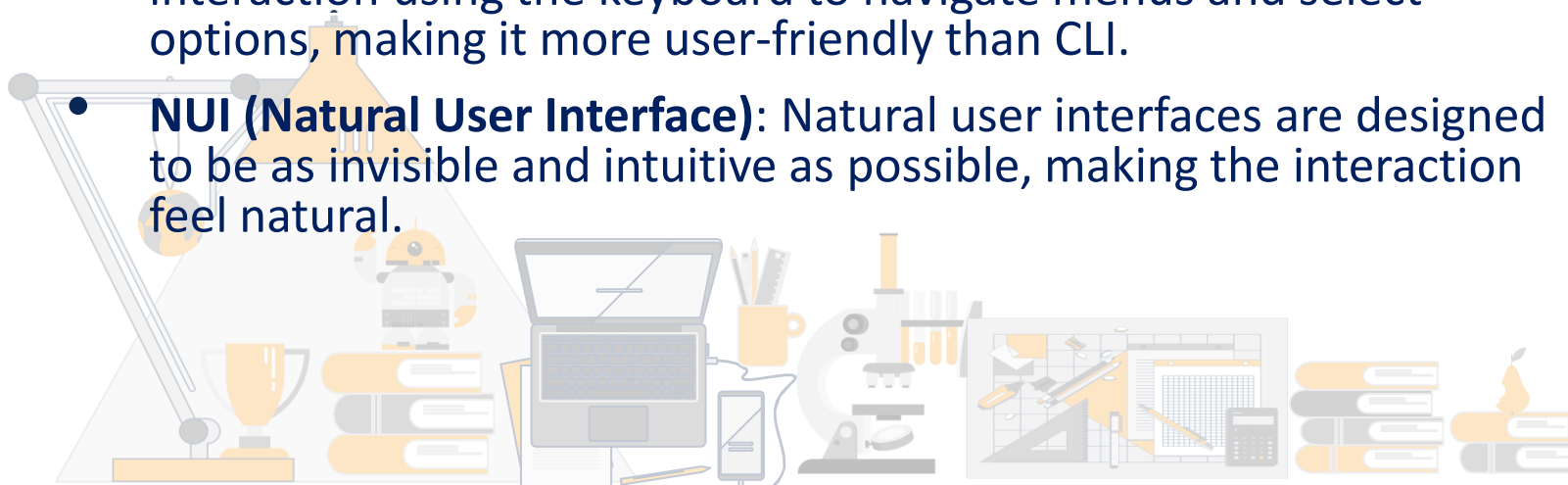
GUI isn't the only way to interact with technology. There are a few other ways to do it, each with distinct advantages and disadvantages:

- **CLI (Command Line Interface):** A command line interface requires users to interact with the system by typing text-based commands. While this gives users powerful control and flexibility, it also has a steep learning curve compared to GUIs, which are more intuitive and visual.
- **TUI (Text User Interface):** A text user interface is somewhat of a bridge between CLI and GUI. It's text-based but allows for interaction using the keyboard to navigate menus and select options, making it more user-friendly than CLI.
- **NUI (Natural User Interface):** Natural user interfaces are designed to be as invisible and intuitive as possible, making the interaction feel natural.

Left				File	Command	Options	Right			
/software				Name	Size	MTime	/etc			
/..				4096	Oct 2 04:02		/..			
/ICAClient-3.0				2048	Jan 6 2003		/.java			
/aida-2.1.1				2048	Apr 28 2003		/ada			
/amber-6.0				2048	Feb 27 2004		/conf			
/amber-7.0				2048	Mar 5 2004		/config			
/amber-7.0p				2048	Apr 16 2004		/cron.d			
/amber-8				2048	Dec 22 2004		/default			
~ansys61				34	Jan 7 2003		/dt			
~ansys71				34	Nov 28 2003		/fscklogs			
/ant-1.6				2048	Aug 10 13:26		~fstyp.d			
/apache-1.3.27				2048	Dec 16 2002		~httpd			
/apache-1.3.28				2048	Jan 6 2004		/init.d			
/apache-1.3.33				2048	Feb 7 2005		/js			
/autoconf-2.57				2048	May 27 2004		/lost+found			
/autodock-305				2048	Jan 5 2001		/mail			
/ICAClient-3.0							/cron.d			

Hint: Keys not working in xterms? Use our xterm.ad, .ti and .tcap files.
 aisa:/software>\$

1Help 2Menu 3View 4Edit 5Copy 6RenMov 7Mkdir 8Delete 9PullDn 10Quit



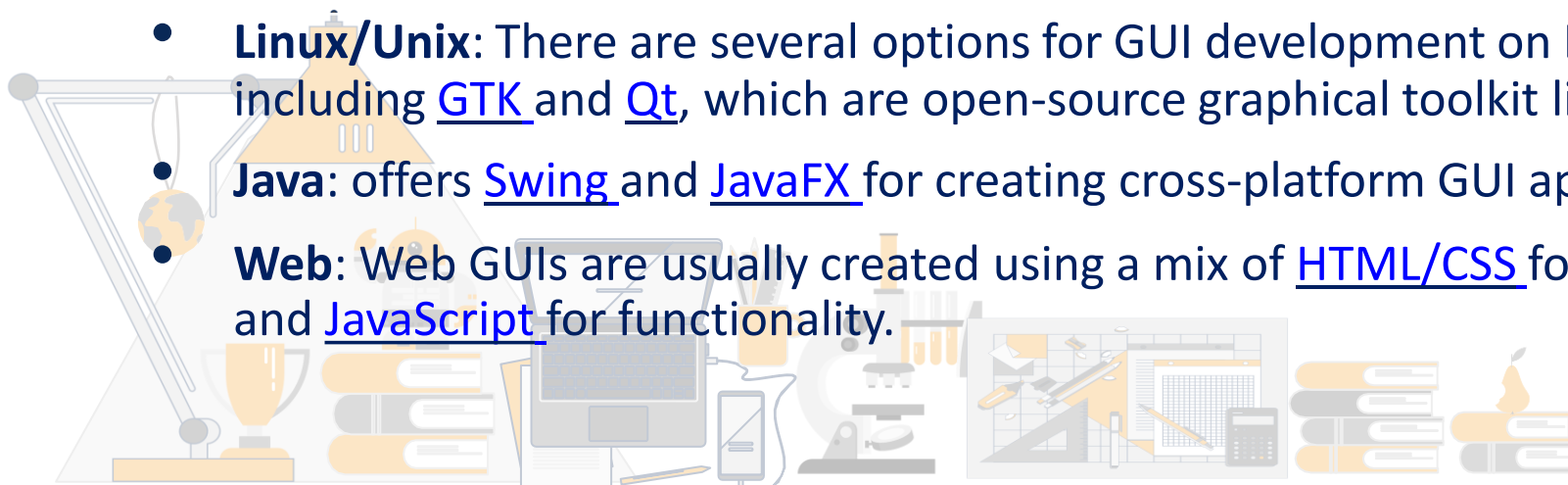
Common GUI platforms and toolkits

A **GUI platform or toolkit**: provides a set of libraries, tools, and APIs (Application Programming Interfaces) that developers use to create graphical user interfaces.

Pre-made components (windows, buttons, dialog boxes) which developers can then customize to suit their application's needs.

A few widely used GUI platforms include:

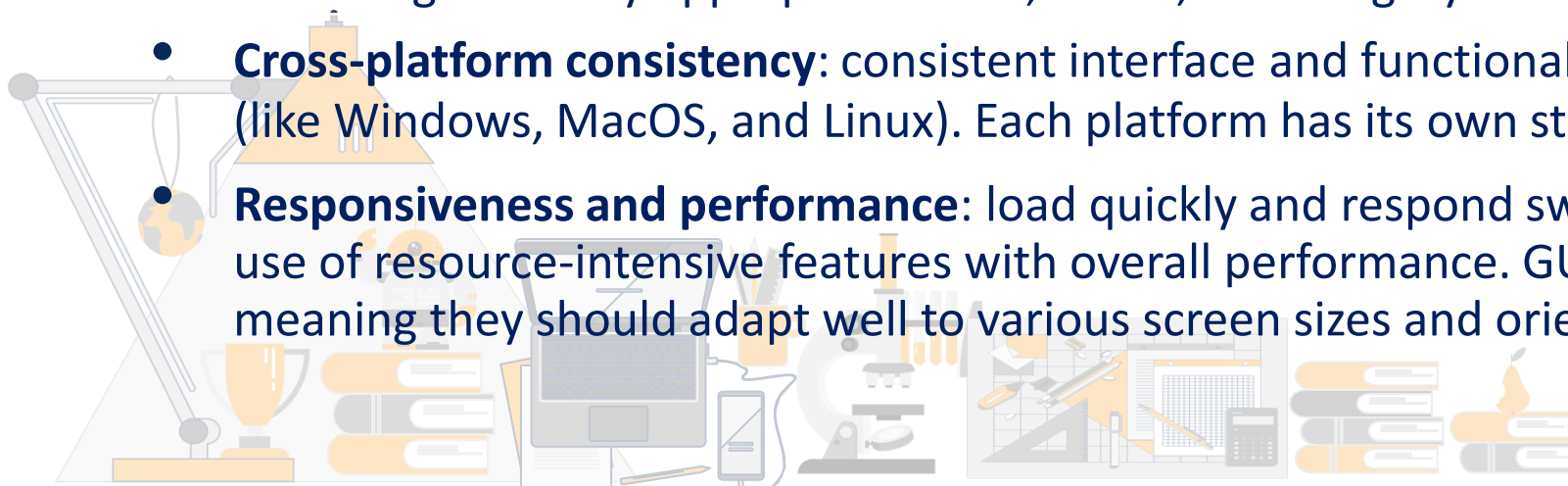
- **Windows**: Microsoft's [Windows](#) platform offers a variety of tools for GUI development, such as [Windows Forms](#) (or WinForms), [WPF](#), and [UWP](#).
- **MacOS**: [MacOS](#) provides developers with [Cocoa](#) for creating native GUIs.
- **Linux/Unix**: There are several options for GUI development on Linux/Unix, including [GTK](#) and [Qt](#), which are open-source graphical toolkit libraries.
- **Java**: offers [Swing](#) and [JavaFX](#) for creating cross-platform GUI applications.
- **Web**: Web GUIs are usually created using a mix of [HTML/CSS](#) for structure and styling and [JavaScript](#) for functionality.



Challenges in GUI design and implementation

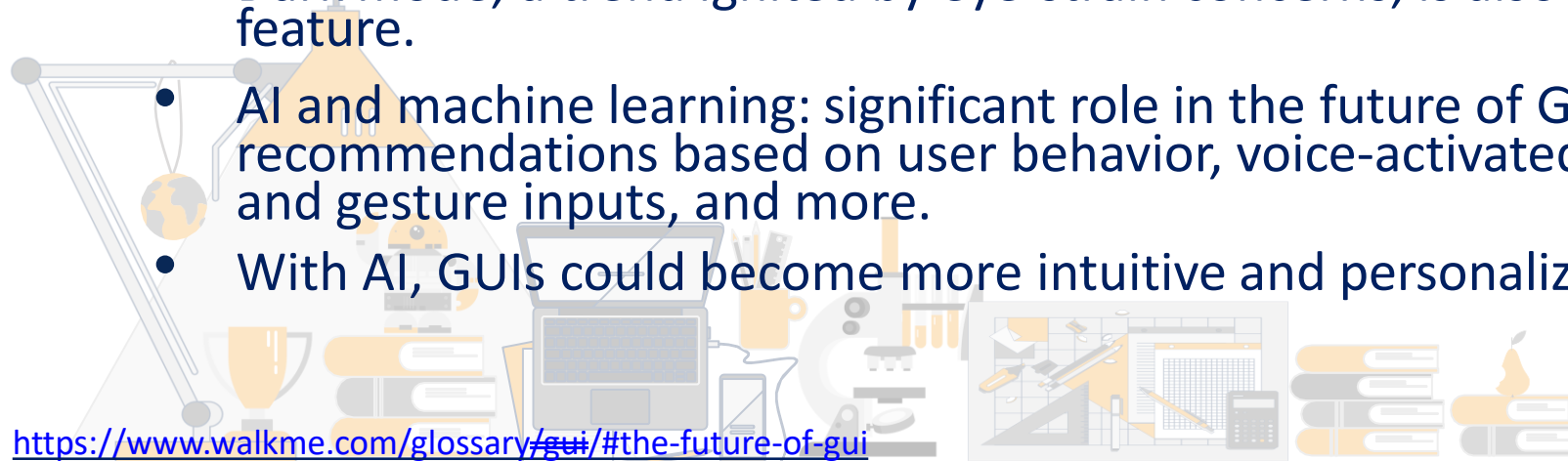
No matter the type of GUI or the toolkit used to create it, a few common challenges permeate the GUI development process. These include:

- **Accessibility:** usable by people of all abilities. Color contrast for visually impaired users, keyboard navigation for those unable to use a mouse, and compatibility with assistive technologies like screen readers.
- **Internationalization and localization:** support multiple languages and cultural contexts. Not only translating text but also adjusting layouts for different writing directions (like right-to-left) and using culturally appropriate icons, colors, and imagery.
- **Cross-platform consistency:** consistent interface and functionality across different platforms (like Windows, MacOS, and Linux). Each platform has its own standards and behaviors.
- **Responsiveness and performance:** load quickly and respond swiftly to user input. Balance the use of resource-intensive features with overall performance. GUIs must be responsive – meaning they should adapt well to various screen sizes and orientations.



The future of GUI

- GUIs are expected to become more immersive and natural as technology advances.
- This can be seen in the growth of virtual and augmented reality, where 3D GUIs are emerging.
- Rise of haptic technology: future GUIs may incorporate tactile feedback, giving a new dimension to user interaction.
- Growing emphasis on minimalism, with clean and simple designs.
- Designs are becoming more personalized and adaptive, adjusting to a user's habits and preferences over time.
- Dark mode, a trend ignited by eye-strain concerns, is also becoming a standard feature.
- AI and machine learning: significant role in the future of GUIs. Intelligent recommendations based on user behavior, voice-activated interfaces, predictive text and gesture inputs, and more.
- With AI, GUIs could become more intuitive and personalized than ever before.



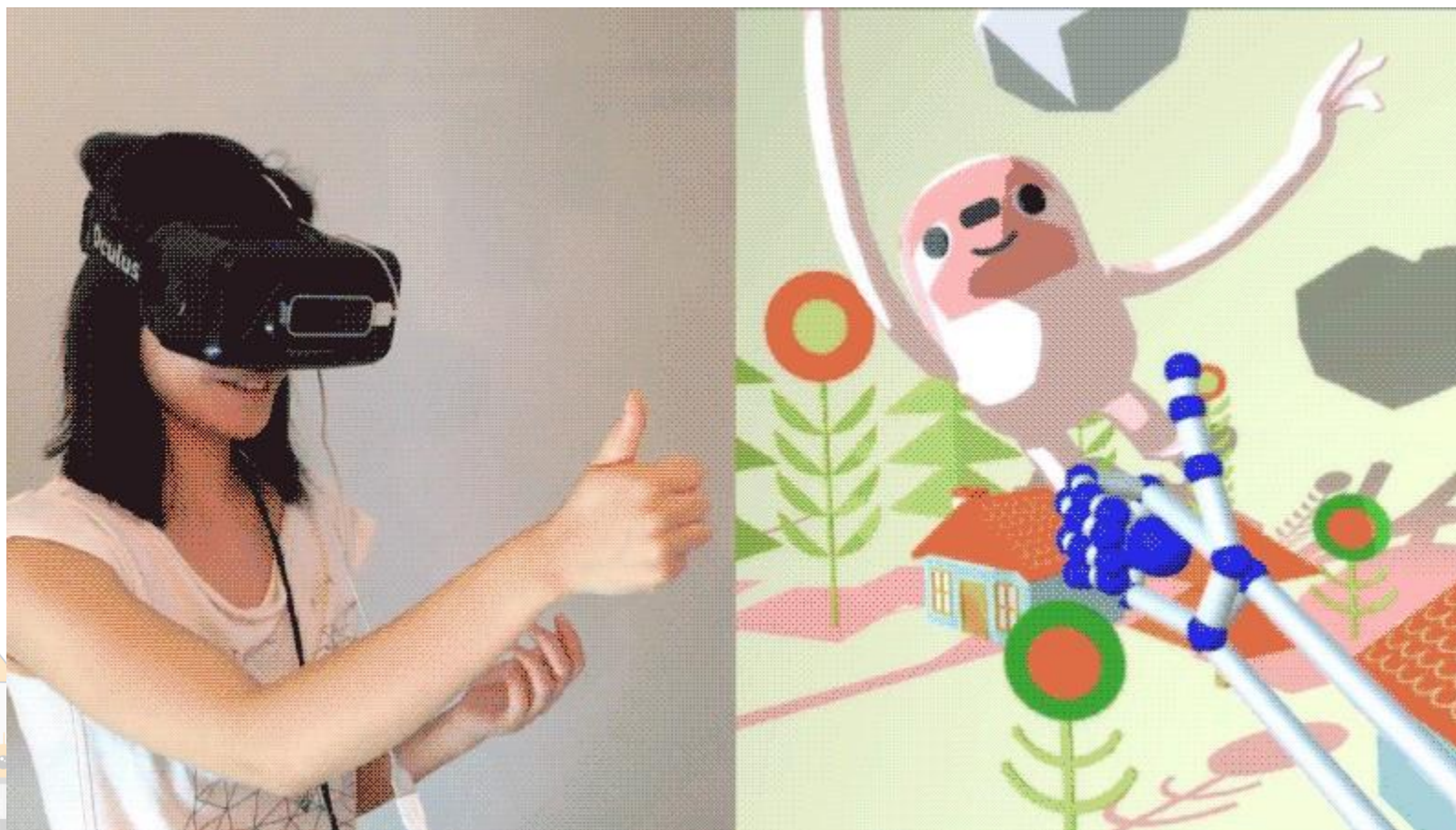
Virtual Reality (VR)



Virtual Reality (VR)

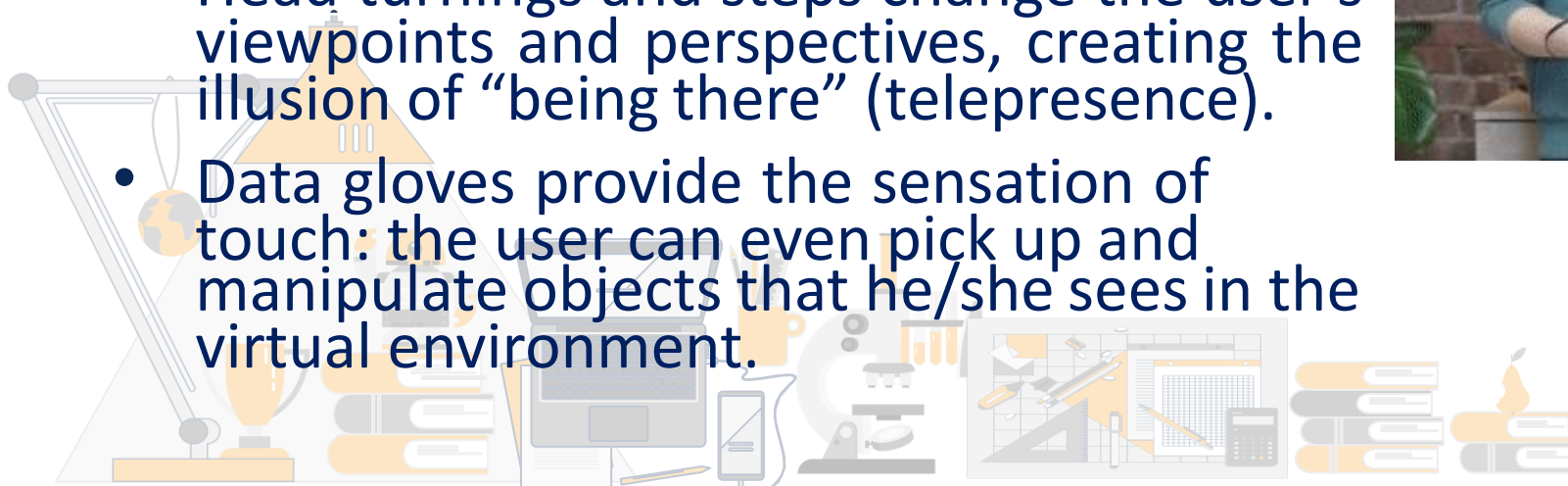
- **What is VR?** The devices and apps that turn the real world virtual.
- **Definition:** the use of computer modeling and simulation that enables a person to interact with an artificial three-dimensional (3-D) visual or other sensory environment.
- Computer-generated environments simulate reality through the use of **interactive devices, which send and receive information** and are worn as goggles, headsets, gloves, or body suits.





A Virtual Reality (VR) example

- A user wearing a helmet with a stereoscopic screen views animated images of a simulated environment.
- Motion sensors pick up the user's movements and adjust the view on the screen accordingly, usually in real time (the instant the user's movement takes place).
- Head turnings and steps change the user's viewpoints and perspectives, creating the illusion of "being there" (telepresence).
- Data gloves provide the sensation of touch: the user can even pick up and manipulate objects that he/she sees in the virtual environment.



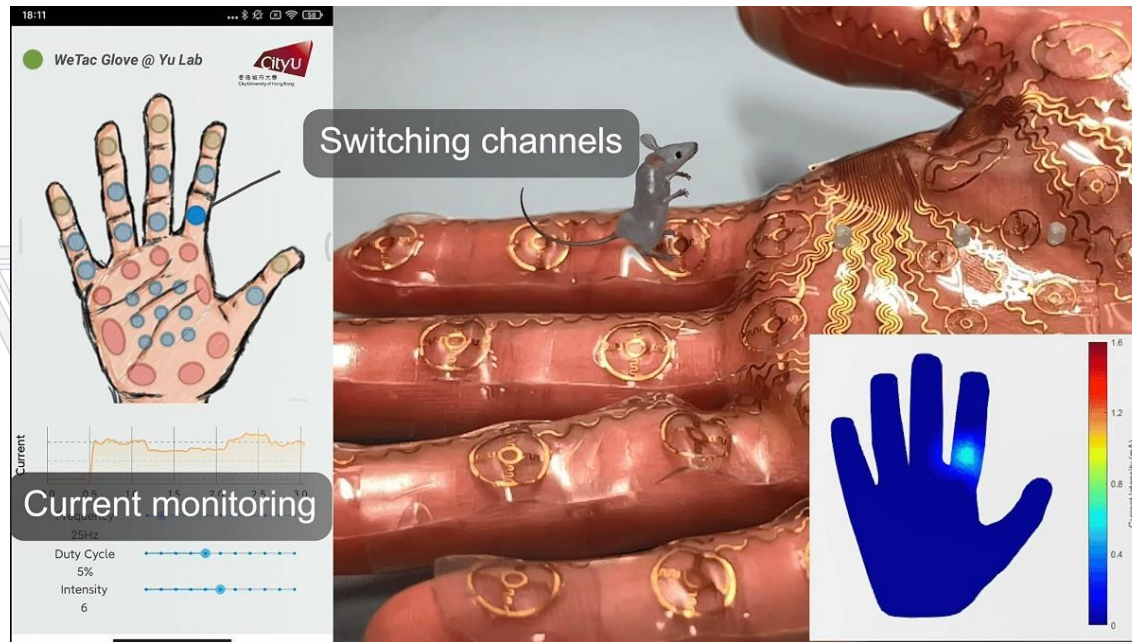


VR Wearables



"Skin VR"

Engineers at the City University of Hong Kong have now developed WeTac, a thin, wearable electronic "skin" that provides tactile feedback to users in VR and AR.

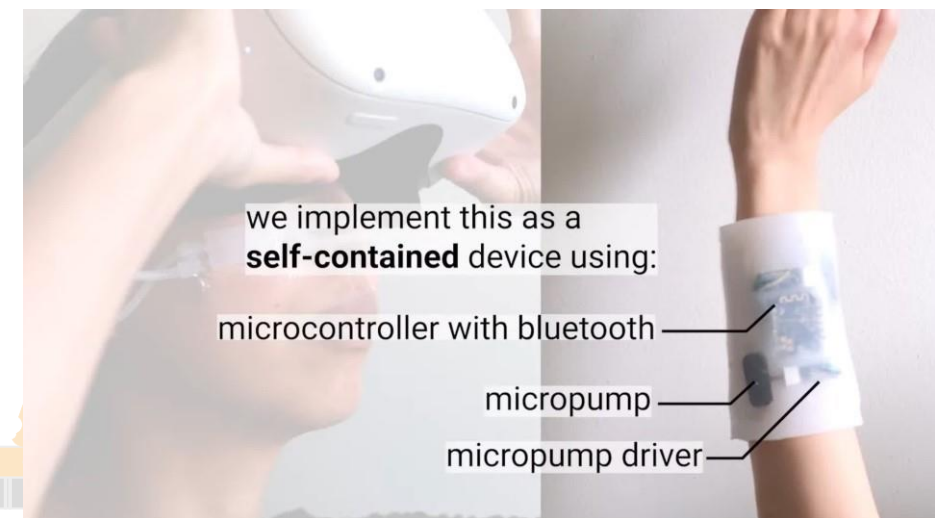
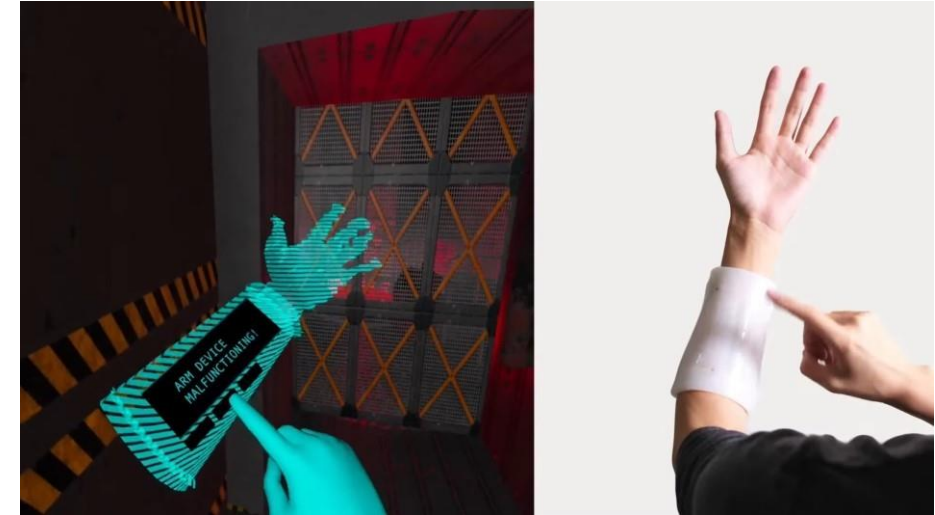


<https://www.youtube.com/watch?v=HDgFwRN7Frk&t=11s>

<https://newatlas.com/wearables/haptic-hydrogel-wearable-touch-vr-ar/>

Chemical haptics 1

- Wearable devices will let you feel cold, heat, and pain in VR by applying chemicals to your skin.
- Chemical haptics use self-contained wearable devices to simulate sensations while in virtual reality.
- The wearables combine silicone patches and micropumps to deliver five different chemicals to the surface of a person's skin.
- Created by researchers from the Human Computer Integration Lab at the University of Chicago.



Chemical haptics 2

Five sensations can be produced by using the various chemicals:

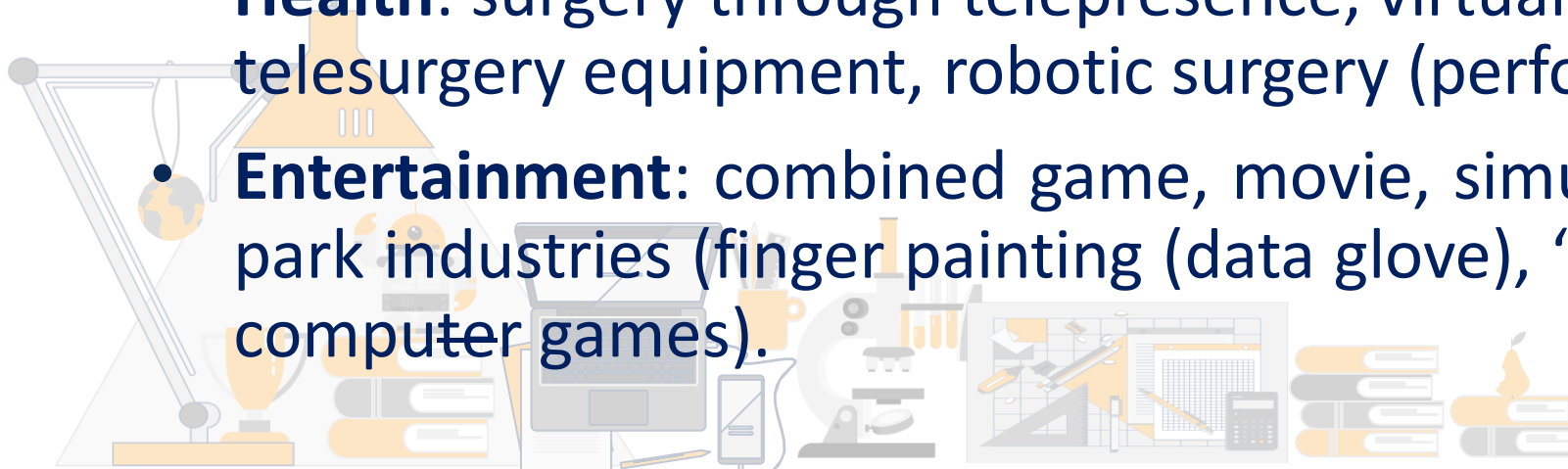
- Menthol: cooling effect
- Capsaicin: sensation of heat
- Sanshool: feel tingly
- Lidocaine: skin feel numb
- Cinnamaldehyde: stinging sensation



<https://www.youtube.com/watch?v=gQ3qBUlj7D4&t=3s>

Virtual Reality (VR) applications

- **Training:** for real-life activities - flight simulators for pilot training, including multiple sensory outputs, force-feedback joysticks, muscle sensors, eye trackers.
- **Research:** study of molecular biology, radiology & ultrasound imaging.
- **Health:** surgery through telepresence, virtual surgery for training, telesurgery equipment, robotic surgery (performed 1998 in Paris).
- **Entertainment:** combined game, movie, simulation, and theme park industries (finger painting (data glove), “air guitar” playing, computer games).



VR: Innovative uses 1

Dining

Now we can **travel virtually** to different places and immerse ourselves in certain environments while tasting the dishes from these locations.



Medicine

The Spanish National Research Council has succeeded in **reducing the effects of Parkinson's** in several patients by applying a treatment that uses VR.



The media

Immersive journalism takes the user to the places where events have occurred with live streaming of 360° videos.



VR: Innovative uses 2



Education

In classrooms, the use of VR allows students to **better retain knowledge** and helps students with learning difficulties.



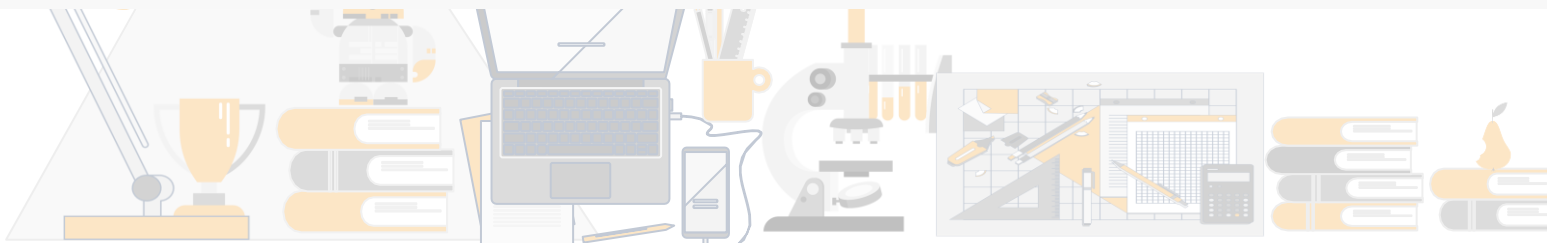
Entertainment

Users can enter a scene in a **video game** or practice **extreme sports** without moving from their sofa.



Architecture

RV helps architects to **better envisage a space** and present the project to their clients.



VR: Innovative uses 3



Industry

Digital Twins are exact digital copies of physical objects that factory workers can **practice on and test in a virtual world.**



Culture/Art

Some museums and galleries offer **virtual visits** or immersive experiences to help understand the history and culture associated with each work.



Military

The UK Ministry of Defence uses VR for **training in simulated combat environments.**





Using VR for training



Using VR for training





<https://www.youtube.com/watch?v=TFZu-9igt1o>



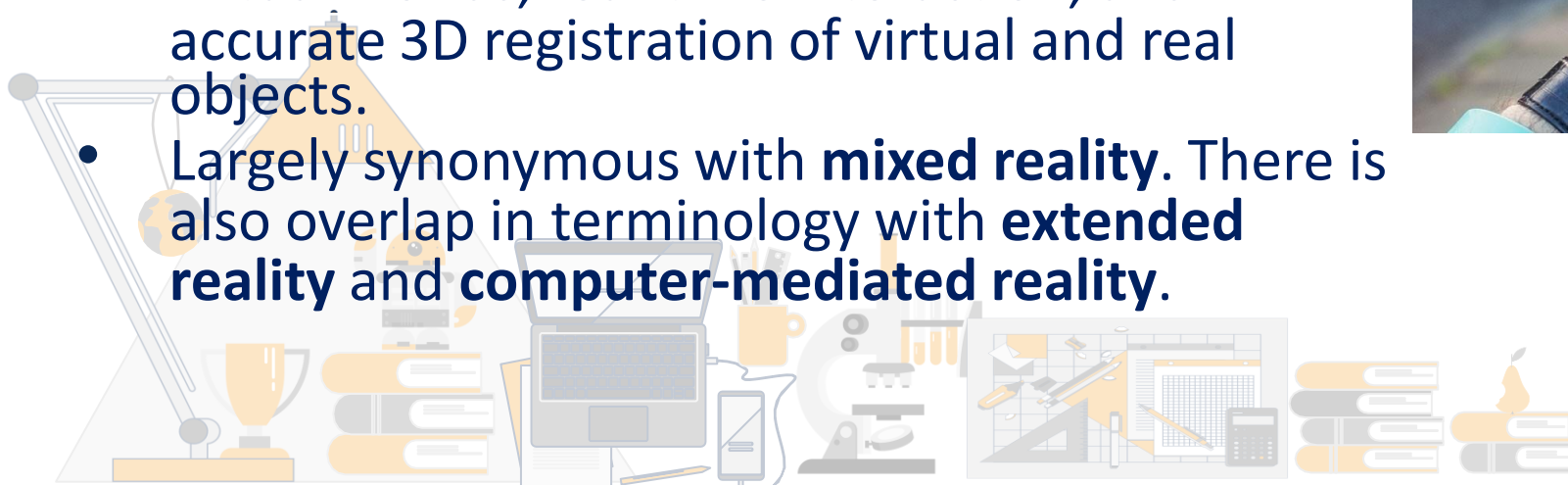
<https://www.youtube.com/watch?v=Z4QV22VGfGs>

Augmented Reality (AR)



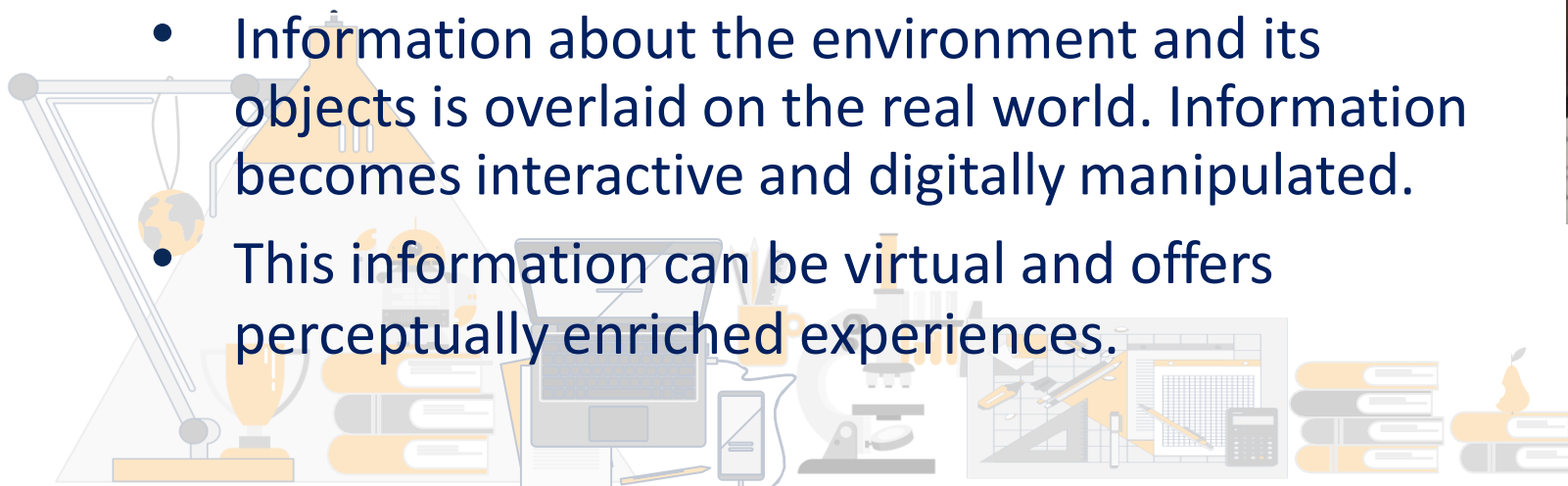
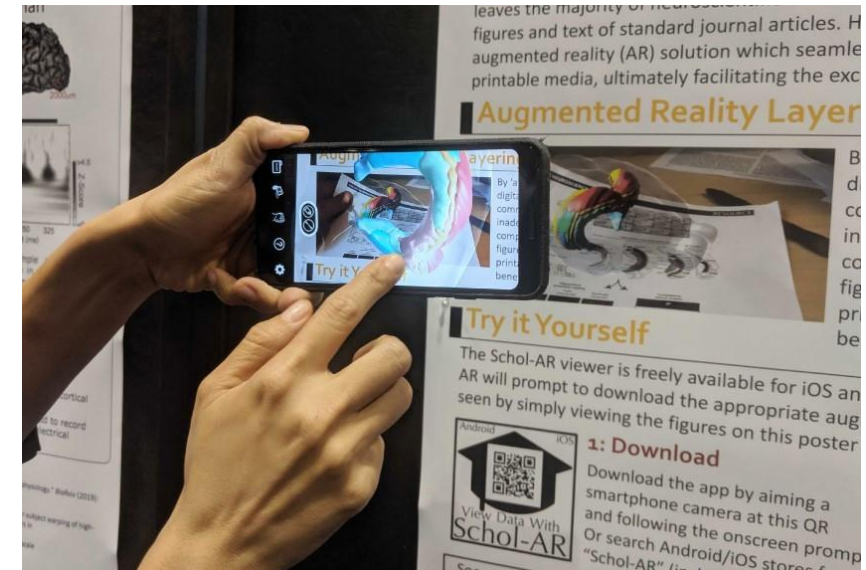
Augmented Reality (AR)

- Augmented reality (AR) is an **interactive experience** that combines the real world and computer-generated content.
- The content can span **multiple sensory modalities**, including visual, auditory, haptic, somatosensory and olfactory (the sense of smell).
- **Three basic features:** a combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects.
- Largely synonymous with **mixed reality**. There is also overlap in terminology with **extended reality** and **computer-mediated reality**.



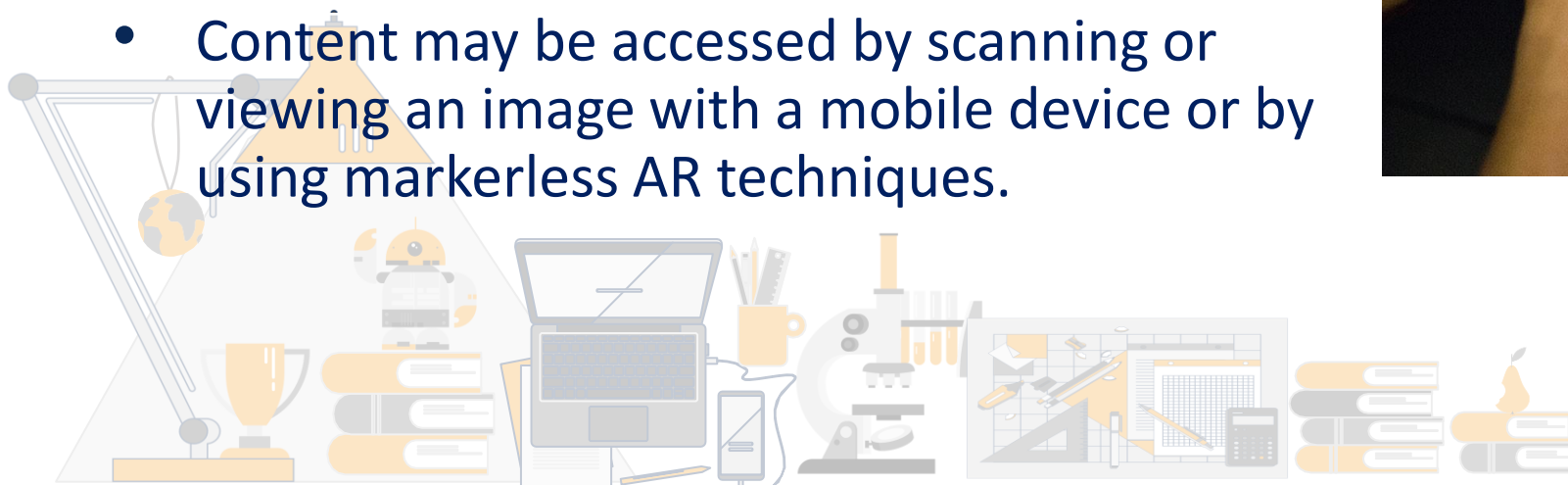
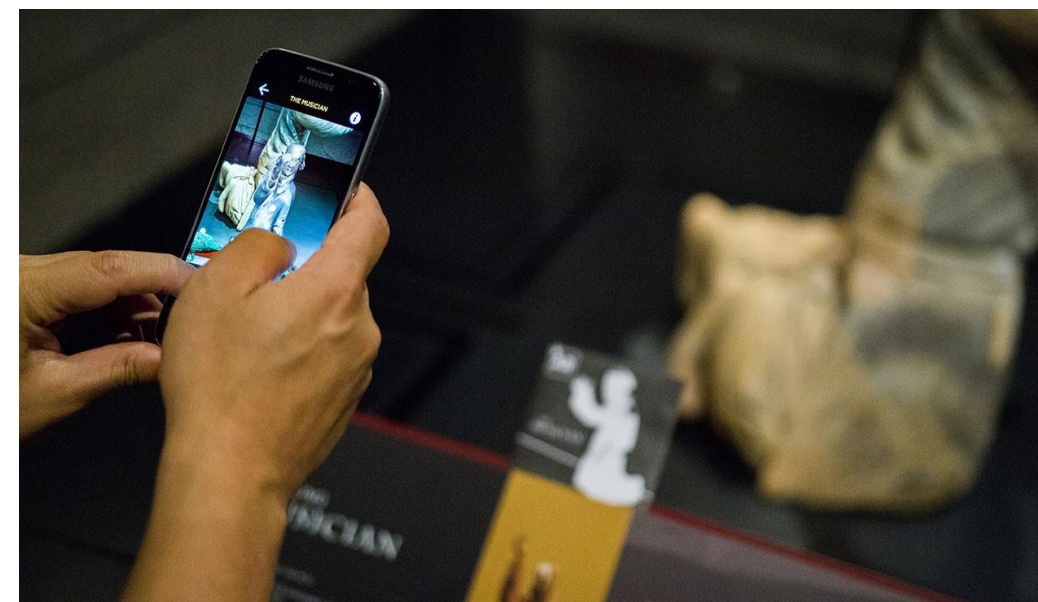
Augmented Reality (AR)

- Augmented Reality is any experience which is artificial and which adds to the already existing reality.
- Natural environments or situations are enhanced by AR technologies, such as: e.g. adding computer vision, incorporating AR cameras into smartphone applications, and object recognition.
- Information about the environment and its objects is overlaid on the real world. Information becomes interactive and digitally manipulated.
- This information can be virtual and offers perceptually enriched experiences.



Augmented Reality (AR)

- Components of the digital world blend into a person's perception of the real world, not as a simple display of data, but through the integration of immersive sensations, which are perceived as natural parts of an environment.
- Content may be accessed by scanning or viewing an image with a mobile device or by using markerless AR techniques.



Uses of AR

Augmented reality applications are diverse from industry to industry. Here are a few top uses that have found their manifestation in existing solutions:

- **Education** (anatomy learning for medical students)
- **Fashion** (AR mirrors, Try-on apps, Runway shows)
- **Retail** (Packaging solutions, try-before-you-buy, virtual fitting rooms)
- **Healthcare** (Billing concierge, symptom description by patients, AR turmoil models for surgeons, etc.)
- **Entertainment**
- **Military training** (Tactical AR – TAR)
- **Mockup creation** in interior design



Photography and Editing



Examples of Augmented Reality

Hololens



Google Glass



Examples of Augmented Reality

Pokemon Go



Google ARCore

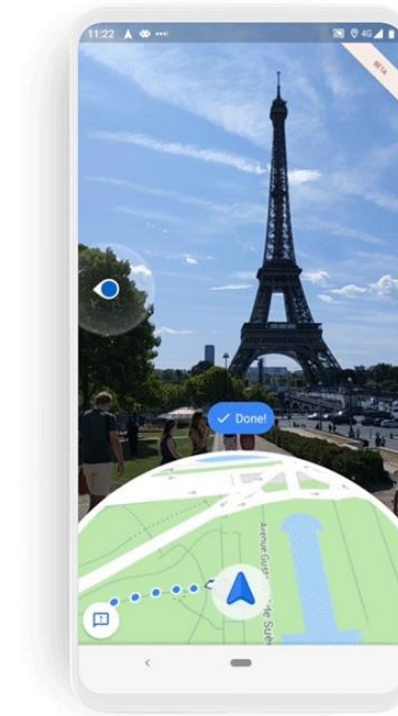


Examples of Augmented Reality

AR Maintenance



Google Street View



Examples of Augmented Reality

Interior Decoration Apps

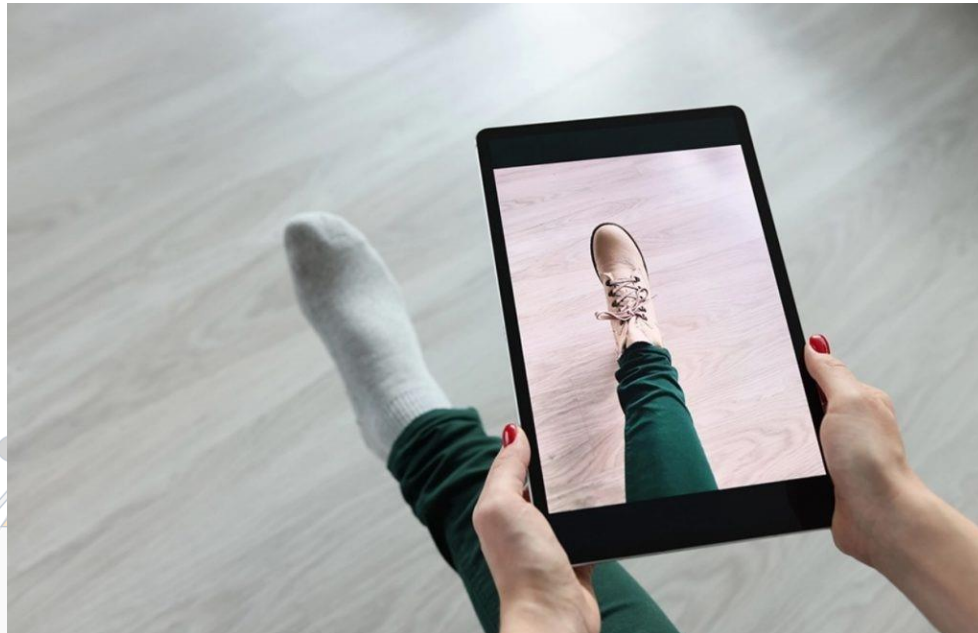


Arki Architecture application



Examples of Augmented Reality

Gucci – virtual sneakers



Amazon – hair colouring

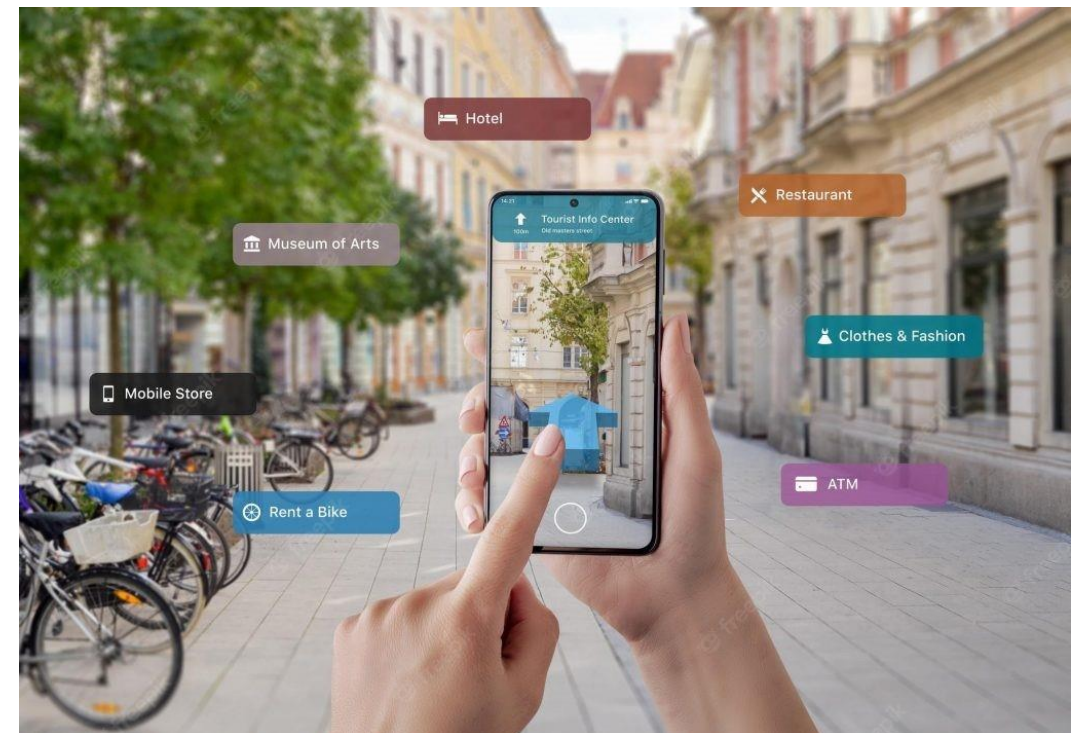


Examples of Augmented Reality

Neurosurgery



Tourism App “World around me”



<https://studiousguy.com/examples-augmented-reality/>

Examples of Augmented Reality

Smithsonian's National Museum of Natural History



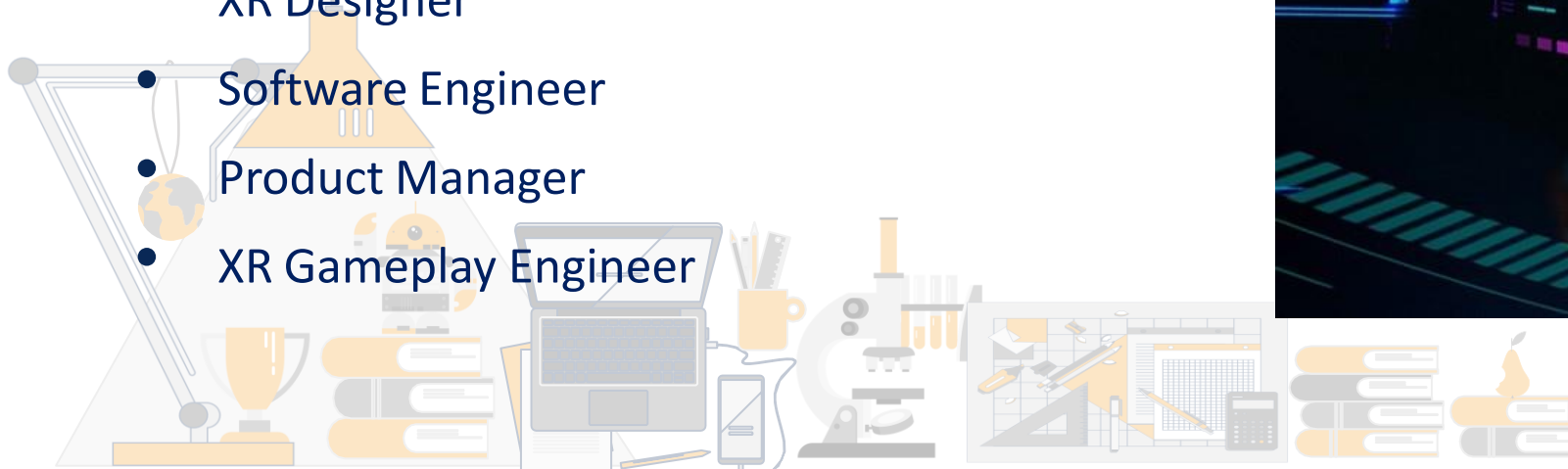
Metro AR Newspaper



In-Demand AR and VR Jobs

As **extended reality (XR)** tech – encompassing augmented reality (AR), virtual reality (VR), and mixed reality (MR) – evolves and applications multiply, fresh opportunities for VR and AR jobs abound.

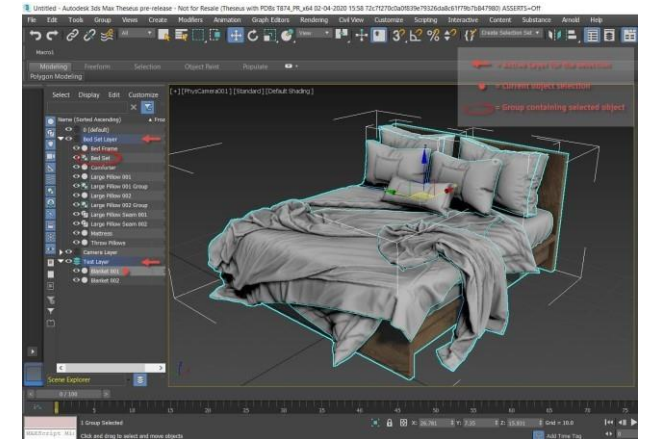
- XR Developer
- Software Developer
- AR/VR Maintenance and Support Technician
- XR Designer
- Software Engineer
- Product Manager
- XR Gameplay Engineer



Augmented Reality Development

The technology used for Augmented Reality Development:

- [iOS Artkit](#)
- [Vuforia](#)
- [Microsoft Mixed Reality Toolkit](#)
- [Android ARCore](#)
- [ARToolKit](#)
- [3DS Max](#)
- [Unity3D](#)



Augmented Reality (AR) Development Software

Popular AR Development products used by Augmented Reality professionals



ARKit

★★★★★ (74)
4.3 out of 5 stars



ARCore

★★★★★ (80)
4.5 out of 5 stars



Vuforia Engine

★★★★★ (53)
4.2 out of 5 stars



Stroom

★★★★★ (45)
4.6 out of 5 stars



Zapworks

★★★★★ (30)
4.5 out of 5 stars



MirrAR

★★★★★ (27)
4.6 out of 5 stars



Augmented Reality (AR) Game Engine

Popular AR Game Engine products used by Augmented Reality professionals



Unity

★★★★★ (350)
4.6 out of 5 stars



Unreal Engine

★★★★★ (137)
4.5 out of 5 stars



ARKit

★★★★★ (74)
4.3 out of 5 stars



Vuforia Engine

★★★★★ (53)
4.2 out of 5 stars



Nuke

★★★★★ (59)
4.5 out of 5 stars



HeroMirror

★★★★★ (1)
4.5 out of 5 stars



AR origins

- Augmented, the word, has been derived from a Latin word 'augere' meaning to add or increase.
- Augmented reality is used to virtually bring a digital object into the real-life world. Also known as mixed reality because reality is augmented by superimposing virtual images over a physical object.
- Somewhat related to virtual reality as both make use of artificial digital objects to create a live experience.





- Used to digitally place an object on the surface of a real-life existing body. AR allows us to interact with virtual stuff just like it is actually present in front of us.
- The device supporting the AR feature uses the lens to scan the object on which the digital impression is to be created. The algorithm and the software then measure the distance of the object. Finally, the object is digitally placed over it.
- AR is, in fact, an enhancement version of the real physical world.



AR sample – explore earth



<https://www.youtube.com/watch?v=47GVkOv9RuA>

VR vs AR

What's the Difference Between the Two?

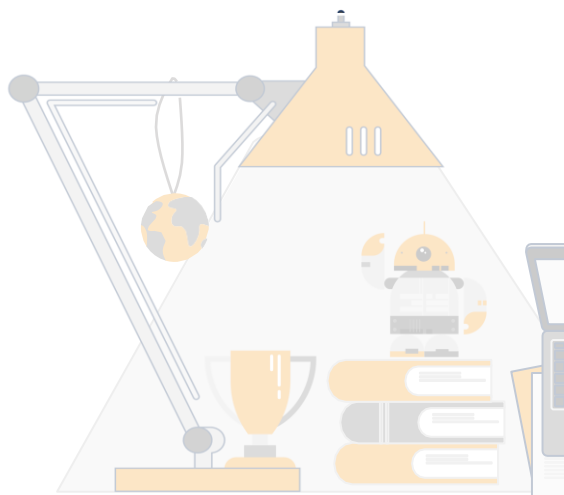
The distinctions between VR and AR come down to the devices they require and the experience itself:

- AR uses a **real-world setting** while VR is **completely virtual**
- AR users can **control their presence** in the real world; VR users are **controlled by the system**
- VR requires a **headset device**, but AR can be accessed with a **smartphone**
- AR enhances both the **virtual and real world** while VR only enhances a **fictional reality**



VR vs AR

- Augmented reality (AR) involves overlaying visual, auditory, or other sensory information onto the real world to enhance one's experience.
- Retailers and other companies can use augmented reality to promote products or services, launch novel marketing campaigns, and collect unique user data.
- Unlike **virtual reality**, which creates its **own cyber environment**, **augmented reality adds** content and information **to the existing world**.



Virtual Reality (VR)

Augmented Reality (AR)

Mixed Reality (MR)



Fully artificial enviroment



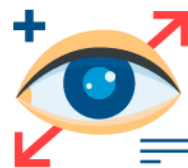
Virtual objects overlaid
on real-world enviroment



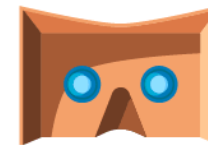
Virtual enviroment combined
with real world



Fully immersion in virtual
enviroment



The real world enhanced
with digital objects



Interact with both the real world
and the virtual enviroment





VS



AUGMENTED REALITY

- Overlays computer generated 3D content on the real world
- User is able to interact with real world and virtual world
- User can clearly distinguish between both the worlds.
- It is achieved by smartphones, tablets or AR wearables.

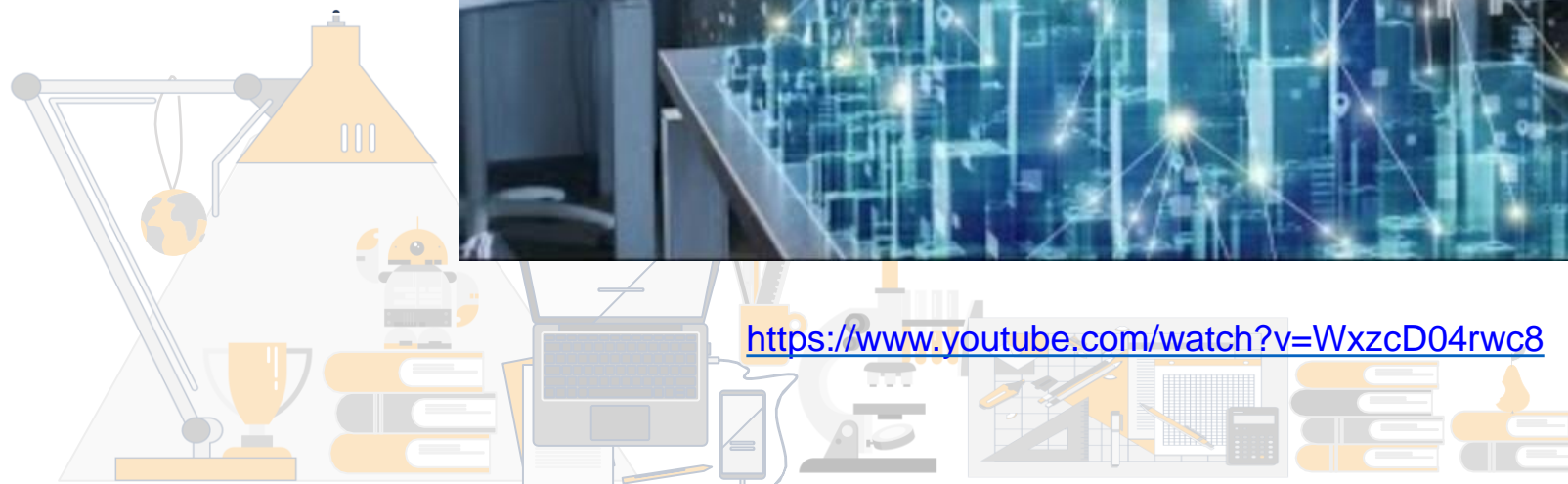
VIRTUAL REALITY

- Visually immerse the user with simulated objects and environment.
- Completely shut down the real world and make user think that they are really in the virtual world.
- User finds it hard to differentiate between virtual and real world.
- It is achieved by VR headsets.

AR examples



<https://www.youtube.com/watch?v=WxzcD04rwc8>



Scan me!



Scan me!



Scan me!



Scan me!



Scan me!



Scan me!



Scan me!



Create AR with Blippar



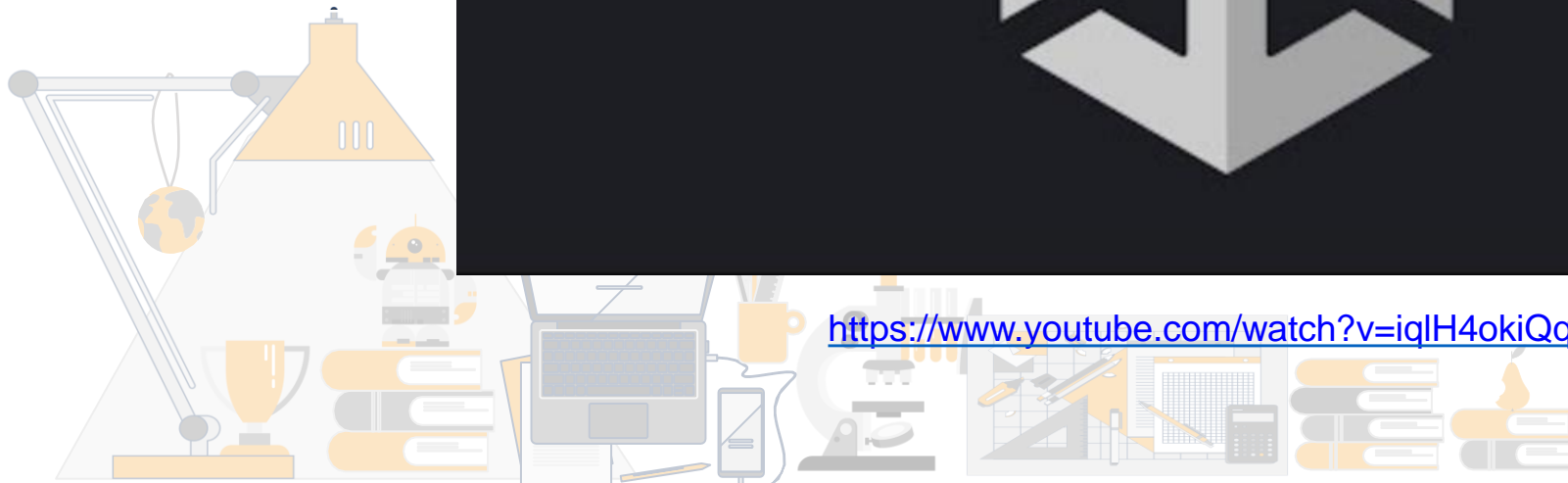
<https://www.youtube.com/watch?v=vuG-xBVyUtA>

Create AR with Unity

100 *SECONDS OF*



<https://www.youtube.com/watch?v=iqlH4okiQgg>



Further reading



- <https://www.copadata.com/en/product/zenon-software-platform-for-industrial-automation-energy-automation/visualization-control/what-is-hmi/>
- <https://inductiveautomation.com/resources/article/what-is-hmi>
- <https://thecxlead.com/tools/best-ui-ux-design-software/>
- <https://next.reality.news/news/50-best-augmented-reality-apps-for-iphone-ipad-android-devices-0183909/>
- <https://learn.unity.com/tutorial/instantiating-ar-models-into-a-virtual-scene#>
- <https://www.pcmag.com/encyclopedia/term/gui>





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