CSC 451 (Principles of Graphical User Interface) Lecture Note 3

The graphic user interface is one of the most important innovations in the history of personal computing. Today, GUIs provide a fundamental platform for human-computer interaction, and it's nearly impossible to imagine how people could live without it.

Since the dawn of computers, developers and designers have dreamed of creating friendly human-computer interaction (HCI). These HCIs make for computer operations that are intuitive and easy to learn without prior practice or knowledge of specific computer languages.

Creating a graphical user interface (GUI), which allows users to directly interact with their devices and complete certain tasks by manipulating elements like icons and scroll bars, is one way designers make their digital devices more efficient and usable.

In this article, we will review the concept of a GUI, how it works, the GUI design process, and principles to follow when creating GUIs.

What is a graphical user interface?

Simply put, GUIs help your users do things within your device, platform, program, or app without needing to type commands or know the coding behind the action.

Some specific examples are:

- Moving a document into the "Trash" folder on your desktop
- Clicking on an icon to launch an application
- Moving files from one folder to another

To better understand the underlying idea of this type of interface, we need to dive into graphical user interface history. While there is no single creator of the GUI, the ideas have roots in Vannevar Bush's work at MIT during World War II. Bush described the concept of a device called memex, in which people could store various types of information. He described memex as an "*enlarged intimate supplement to one's memory*." Bush's ideas influenced computer scientist Ivan Sutherland, who created a system called Sketchpad. Sketchpad was a predecessor to GUI.

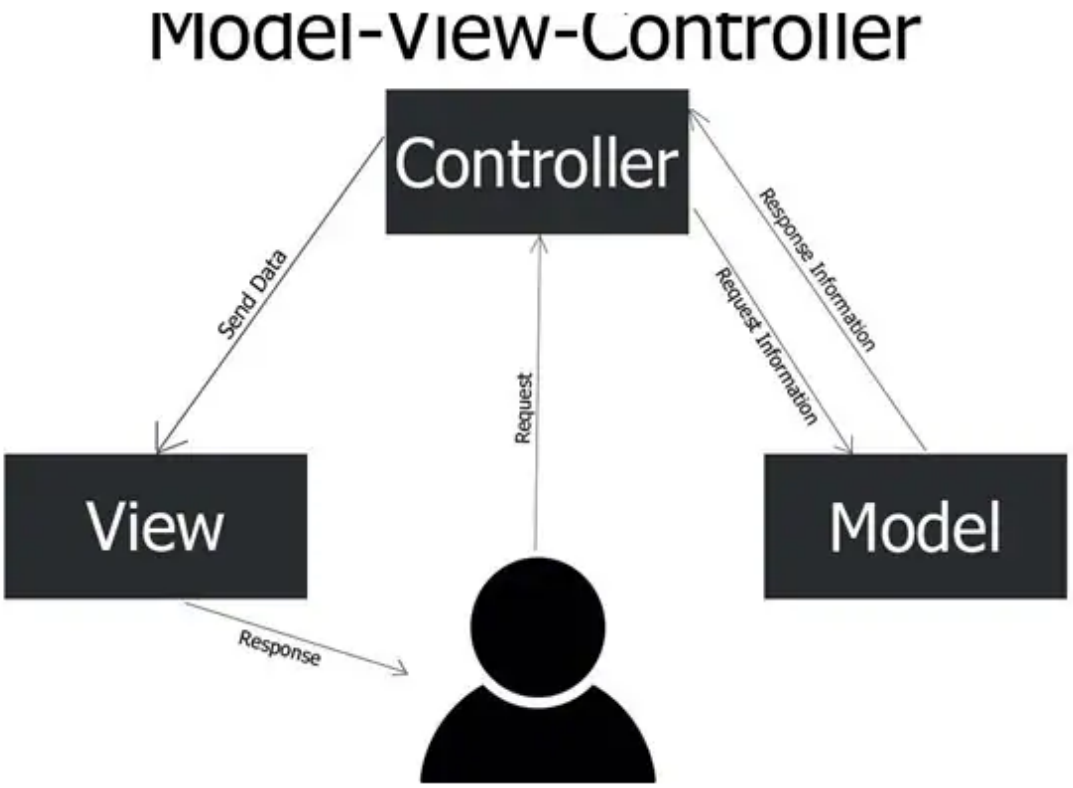
The first working concept of graphical user interface design, however, is from the Xerox Palo Alto research laboratory in the 1970s.

This concept was based on a desktop metaphor—designers tried to simulate a desktop environment. The metaphor of a file and a folder is used to organize the content in a structured way. Later, Apple and Microsoft adopted this concept into their operating systems.

How does a graphical user interface work?

GUIs consist of graphical elements that users interact with. The most common paradigm of GUIs is the windows, icons, menus, and pointer (WIMP). The WIMP paradigm refers to virtual input devices controlled by a physical pointing device (a mouse), the content containers (windows), and graphical objects used to initiate some actions (icons and menus).

Most graphical user interfaces reference the model-view-controller (MVC) pattern. This pattern separates internal representations of information (model) from the manner in which users receive it (view). The controller acts as a medium between two parties.



MVC allows for flexible structures, so you can redesign elements without any changes to the model. The view then becomes almost like a visual skin that designers can apply to the same business logic of the application.

Advantages and disadvantages of graphical user interfaces

In comparison with a command-line user interface, GUIs have many advantages:

- **Lower learning curve.** With a GUI, users don't need to learn specific commands or have expert computer skills.
- **Lower interaction cost.** The user doesn't have to type commands using a keyboard; they can navigate to the graphical object and click or tap on it to perform the action.
- **Immediate feedback.** Users manipulate objects in real-time and can see the results of their actions.

But there are also some disadvantages to this model:

- **Easier to make errors.** To make an error in a command-line interface, you need to type a command and execute it. To make an error in the GUI, all you need to do is to click the wrong button.
- **Built-in limitations.** Unlike with GUIs, the command-line interface offers more freedom and flexibility for experienced users, allowing them to execute some complex operations or weak system confirmation.

GUI design process

It's impossible to think about GUI design in isolation from a product that will use it. Thus, the design process below is just an extract from a general five stages of the design thinking process (Empathize, Define, Ideate, Prototype, and Test) that product design teams use.

Requirement gathering

Good UI design is about understanding your user's needs. Designers need to think about the tasks the user will complete using a product (user needs), as well as *when* (user environment) and *how* (design ergonomics), and turn this information into functional requirements. At the end of this step, product designers should be able to answer the following questions:

- What will the user want the system to do?
- What features should the product support?
- How will the product fit into the user's daily activities?
- Where will the user interact with the system?

Design information architecture

UX psychology plays a critical role in GUI design. Interactions with GUI should feel natural for users, and that only happens when features and content align with user mental models. That's why after learning about requirements for the system, it's important to structure content and functionality in a way that makes sense for the user.

One way to do this is by creating a hierarchy of pages to help users find information without much effort. For example, when users launch a document editing app, they expect to find all editing options in the top-level menu. Hiding or changing the position of key controls will make the interaction with a product more difficult for your users.

Prototyping

In this step, we try to create a visual representation of a GUI. Product design is an iterative process and depending on the stage of product design, prototyping can be anything from low-fidelity clickable wireframes to a high-fidelity coded prototype that looks and works almost like a finished product.

Testing

Product design is an iterative process and it's nearly impossible to create a perfect solution right from the first attempt. Testing with people who represent your target audience will help you understand how well your product works for your users and what areas for improvement you have. Great design teams follow a build-measure-learn cycle until they've created a solution that is good enough for their users.

Principles to consider when designing GUIs

The general principles of the user interface can be given as follows:

i. Aesthetically Pleasing:

- A design is aesthetically pleasing if it is attractive to the eye. It draws attention subliminally, conveying a message clearly & quickly.
- Visual appeal is provided by following the presentation & graphic design principles which include meaningful contrast between screen elements, creating spatial groupings, aligning screen elements, providing three-dimensional representation,& using color & graphics effectively.

ii. Clarity:

- User interface must be clear in visual appearance, concept & wording.

- Visual elements should be understandable & related to real world concepts & functions. Analogies should be simple.
- Interface words & text should be simple, unambiguous,& free of computer jargon.

iii. Compatibility:

Compatibility needs to be provided as

- User Compatibility:"Know the user" is the fundamental principle in interface design as no users are alike & they think, feel & behave differently compared to the developer.
- Task & job compatibility: The structure & flow of functions should permit easy transition between tasks. The user must never be forced to navigate between applications or many screens to complete routine daily tasks.
- Product compatibility: compatibility across products must always be considered in relation to improving interfaces, making new systems compatible with existing systems will take advantage of what users already know & reduce the necessity for new learning.

iv. Comprehensibility:

- The steps to complete a task should be obvious. System should be understandable & flowing in meaningful order.
- A user should know what to look at, what to do, when to do it, where to do it, why to do it & how to do it.

v. Configurability:

- A default configuration as well as easy personalization & customization through configuration and reconfiguration should be provided.
- Customization enhances sense of control, encourages an active role in understanding & allows personal preferences & differences in experience levels leading to high user satisfaction.

vi. Consistency:

- Consistency is important because it can reduce requirements for human learning by allowing skills learned in one situation to be transferred to another like it.
- Any new system must impose some learning requirements on its uses but avoid unnecessary activity.

vii. Control:

- The user must control the interaction & never be interrupted for errors.
- Actions should result from explicit user requests & be performed quickly.

viii. Directness:

- Tasks should be performed directly & alternatives should be visible reducing the user's mental workload.
- Tasks are performed by directly selecting an object then selecting an action performed & then seeing the action being performed.

ix. Efficiency:

- Transition between various systems controls should flow easily & freely.
- Navigation paths should be as short as possible.
- Eye movement through a screen should be obvious & sequential.

x. Familiarity:

- Build into the interface concepts, terminology, workflows & spatial arrangements already familiar to the user.
- Familiar concepts enable people to get started & become productive quickly.

xi. Flexibility:

- Flexibility is the system's ability to respond to individual differences in people.
- Permitting system customization.

xii. Forgiveness:

- People will make mistakes; a system should be able to tolerate those that are common & unavoidable.
- A forgiving system keeps people out of trouble.

xiii. Predictability:

- All actions should lead to results the user expects. Current operations should provide clues as to what will come next.
- Design consistency enhances predictability.

xiv. Recovery:

- A person should be able to retract any action by issuing an undo command.
- The goal is stability or returning easily to the right track when a wrong track has been taken.
- Recovery should be obvious, automatic, easy & natural to perform.

xv. Responsiveness:

- A user must be responded quickly.
- Substantial or more informative feedback is most important for the casual or new system user.
- All requests must be acknowledged in some way.

xvi. Simplicity:

- Simplicity can be achieved by progressive disclosure, provide defaults, minimize screen alignment points, make common actions points,make common actions simpler,& provide uniformity & consistency.

xvii. Transparency:

- Permit the user to focus on the task or job without concerning the mechanics of the interface.
- Working & reminders of workings inside the computer should be invisible to the user.

xviii. Trade-Offs:

- Final design will be based on a series of trade-offs balancing often-conflicting design principles.
- People's requirements always take precedence over technical requirements.

As we explained earlier, the goal of GUI design is to improve the communication between the human and the machine. We'll dive into some of the generally accepted principles for graphical user interface design below.

Simplicity

"*The best interface is no interface.*"

Golden Krishna

This quote by Golden Krishna refers to the idea that the best interfaces are almost invisible to the user. Any attention devoted to the GUI design itself interferes with the primary task that the user has, which is achieving their goal in the shortest possible amount of time. That's why it's essential to remove all unnecessary elements and polish existing elements for maximum clarity.

Here are a few recommendations for creating an interface that's as simple as possible:

- **Make screens less crowded by removing all unnecessary details.** Leave only elements that are the most important for user tasks.
- **Make it easier for users to discover important elements or actions.** Prominently feature important functions, and hide less frequently used functions.

Aesthetic-usability effect

People judge a book by its cover. This applies to many things in our world, including graphical user interfaces. We see this with the aesthetic-usability effect, which states that users are more tolerant of minor usability issues when they find an interface visually appealing. Good aesthetics can improve the user's perception of the GUI, so it's important to create a design that makes your users happy.

Aesthetics GUI design

What does aesthetics mean?

- The look and feel of an interface
- How engaging it is to viewers
- Invites exploration, etc..
- Layout

- Color scheme
- Typography

Aesthetic GUI Design – Color
Web site's color scheme should enhance the page and help establish or reinforce branding. Should provide a good contrast.
RGB Primary colors:
- Red
- Green
- Blue

RGB Secondary colors
(Two primary colors)
- Magenta
- Cyan
- Yellow

RGB Tertiary colors
(1 Primary and 1 Secondary)

Color Schemes
- Analogous – color schemes use colors that are next to each other on the color wheel. They are usually a good match and create eye-pleasing effects.
- Triadic – colors that are evenly spaced around the color wheel.
- Monochromatic – colors schemes use varying colors, shades or tints of the same hue.
- Complementary – colors are across from each other on the colour wheel.

Graphic File Formats that should be used when designing an interface

JPEG - JPEG (joint photographic experts group), a digital file format that supports millions of different colour options, is often used **to transmit better-quality images**, such as digital photographs, at the cost of greater size.

PNG - Portable Graphics Format is the most frequently used uncompressed raster image format on the internet. This lossless data compression format was created to replace the Graphics Interchange Format (GIF).

- Now commonly used on the web
- Does maintain a transparent background
- “loss less” compression
- Animated with the .APNG extension

GIF - A GIF (Graphical Interchange Format) is an image format with a series of images or soundless video that will loop continuously and doesn't require anyone to press play. They slow down the site or the app and due to their large size, they require a relatively large amount of energy to be transferred and rendered

- Maintains transparent background
- Fewer colors (256 RGB)

Consistency

The principle of consistency states that a system should look and work the same throughout. Inconsistency can make even the most beautiful GUI design completely unusable. Thus, it’s vital to design for visual (similar components should have similar look) and functional (similar components should have similar uses) consistency. A design system—including component libraries and style guides—can help with this.

Familiarity

Good user interface design should also focus on helping users achieve their goals. When it comes to GUI design, creating a familiar experience is a top priority.

Here’s what this means:

- **Use affordances for individual elements to help users decode their meaning.** Affordances are visual properties of objects that show users the actions they can take. Familiar affordances, such as shadows on buttons, help users understand what the element does just by looking at it.

Follow platform conventions. When designers break conventions, they make it harder for users to interact with the product.

Digestibility

When designing GUIs, it's important to make the UI easily digestible. Try not to overload it with too much information, and make sure to optimize both content and functional elements for fast scanning.

Here are a few practical tips:

- **Ensure that all text is legible and readable.** Information should be easy to scan and easy to read.
- **Create a proper visual hierarchy of elements.** The arrangement and alignment of elements on a page should guide users to what they need first, second, and so on.
- **Optimize both content and functional elements for fast visual scanning.** The most common scanning patterns are F-shape and Z-shape.

Efficiency

Anticipating your user's wants and needs with your GUI will help them achieve their goals faster and with less effort. Here's what this looks like:

- **Practice anticipatory design.** Anticipate the natural progression of the task and provide relevant information and actions exactly when users need it.
- **Minimize eye movements** by aligning screen elements into groups.
- **Minimize interaction cost (hand or finger movements)**. Fitts' Law states that the time required for a user to move a pointer (mouse cursor or finger) to a target is a function of the distance to the target divided by the size of the target. Put controls in close proximity to the object that users want to control.

Responsiveness and control

Responsiveness and control are two principles that help to keep a good pace in human-computer dialog. The system should always communicate what's happening because it helps users maintain a sense of control.

Here are a few things to keep in mind:

- **Offer good performance.** Users want to perform actions quickly, without lag.

- **Control the interaction.** Allow users to interrupt or terminate actions, and allow support for "undo" operations.
- **Provide appropriate feedback.** The system you design should rapidly respond to the user's requests with relevant feedback (visual, audio, or any other type). Feedback helps users understand that the system received their command. Without feedback, the user risks making the same operation multiple times (i.e. clicking on the same button twice).

Accessibility

It's also vital to make GUI accessible to all types of users, including those with disabilities. You'll need to take vision, hearing, and mobility issues into account for accessible HCI design.

Here are two essential resources for GUI designers that provide a set of requirements for accessibility:

- Web Content Accessibility Guidelines (WCAG) 2.0 guidelines. Following these guidelines will make your design accessible to a wider range of people with disabilities.
- Accessible Rich Internet Applications (ARIA) specification. This specification covers assistive technologies that help convey information to persons with disabilities.