mekoprint

Tactile feedback

How to specify a great click?

HMI design guide series

The impact of tactile feedback

Tactile feedback is critical for a seamless user experience in electronic devices. The way a button feels and responds is essential for safe and effective operation. It also shapes how users perceive your product, significantly influencing their overall satisfaction.

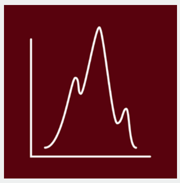
This guide is tailored for industrial designers, engineers, and developers creating **HMIs for electronic devices**. It introduces a straightforward method for measuring and specifying tactile feedback, along with practical scenarios to inspire your designs.

Four factors of tactility

Based on a large number of measurements and testing, we have identified four key factors that **define tactile feedback.** These factors are equally vital and interdependent.

They act as a foundation for discussions during the design process. Keep in mind that tactile feedback is one aspect of user experience—other factors like use cases, materials, and product design must also be considered.

Force
The resistance felt when pressing a button (N).



Snap ratio
The change in resistance as the button is pressed (N/mm.

Travel
The distance a button moves before activation (mm).

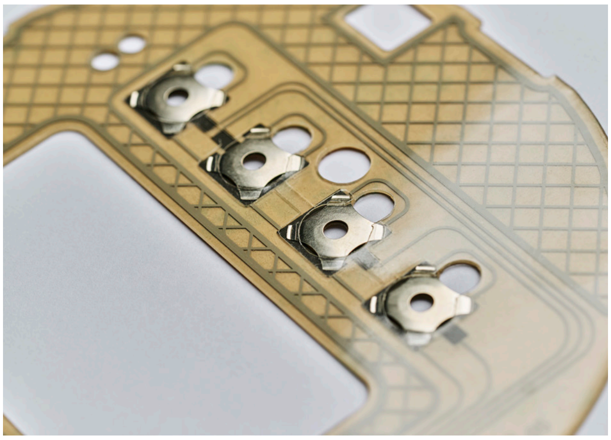
Audio
The sound generated by the button's click (dB).

What makes a click in a keypad?

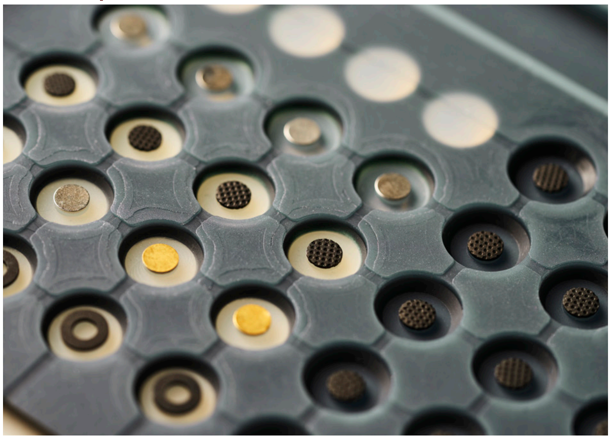
The physical components behind a click can be grouped into four categories:

- metal domes: best for **thin constructions** in silicone and membrane keypads
- tactile switches - suitable for silicone and membrane **keypads with PCBs**
- carbon pills - used in silicone keypads; moulded, screen-printed or glued together with a **silicone actuation pin**
- polydomes - embossed structures in membrane keypads **for compact designs**

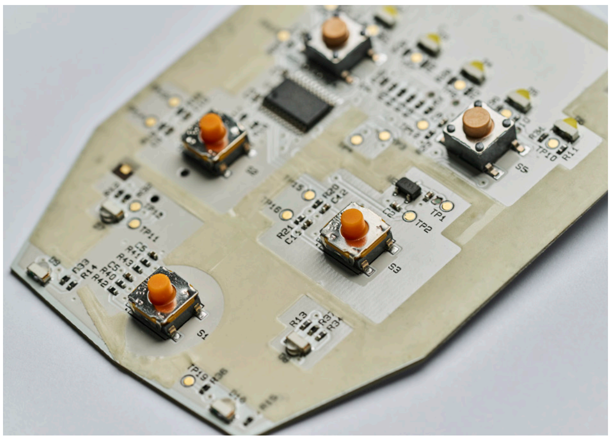
Metal domes



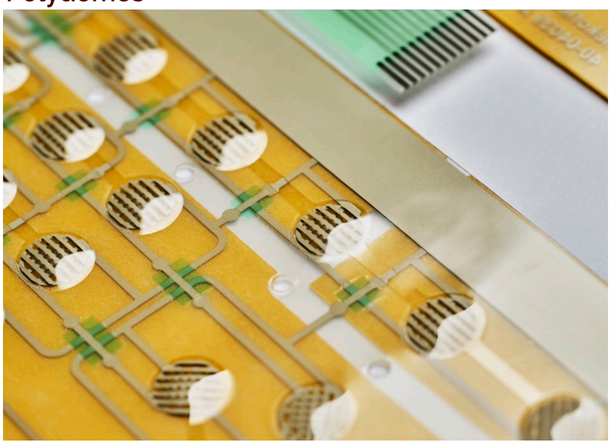
Carbon pills



Tactile switches



Polydomes



Keypad construction types

By combining the four **click components** with two main materials—silicone and membrane switch foils—we get six primary **keypad construction** types. These types can be measured and compared using tactility profiles, which help visualize design options.

	Silicone rubber	Membrane foil
Metal domes		
Tactile switches		
Carbon pills		
Polydomes		

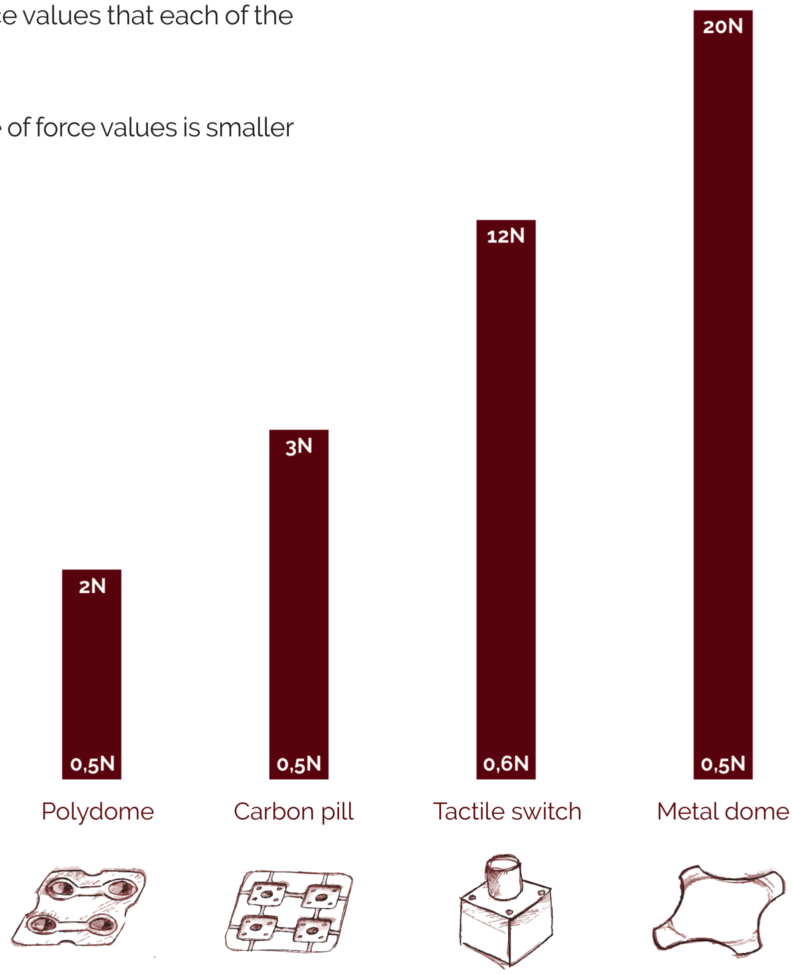
TACTILITY FACTOR

Force

Force determines how much pressure (in Newtons or grams) is needed to **activate a button**.

The illustration shows the range of force values that each of the click types can achieve.

With polydomes for example, the range of force values is smaller than with metal domes.



Design guide takeaway:

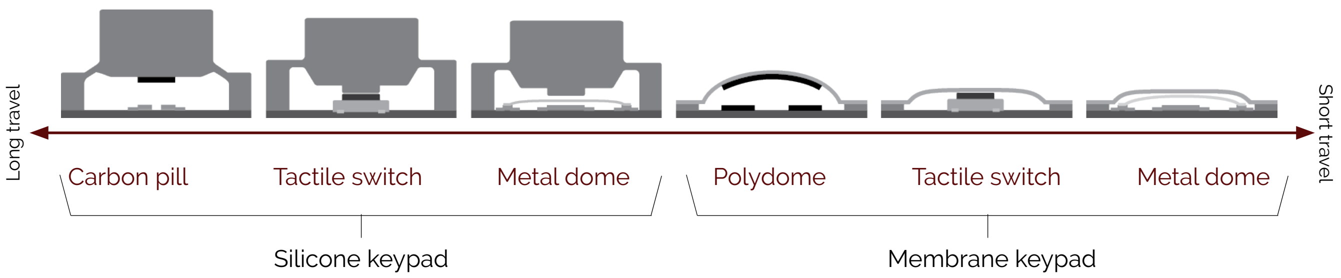
- The higher N value (or grams), the more force you need to activate a button.
- High force: Ideal for critical buttons like emergency stops (e.g., >600 g).
- Low force: Suitable for frequent use where ergonomics are key (e.g., <200 g).

TACTILITY FACTOR
Travel

Travel is expressed in mm. Travel refers to how far a button moves before activation. The illustration shows travel ranges with different keypad constructions.

To the left, keypads with silicone rubber and carbon pills have a **long travel** because of the construction. On the other end of the scale, membrane keypads with metal domes allow for very **short travels** thanks to its slim construction.

The construction of your device and the keypad required usually set the frame for how long travel for a button is needed.



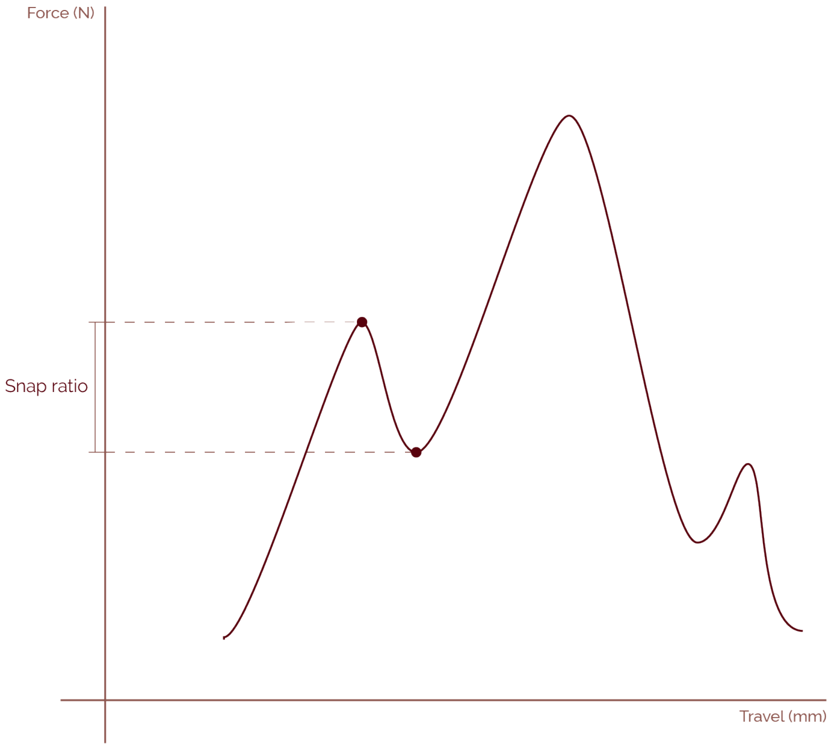
Design guide takeaway:

- The higher travel – the longer the movement of the button
- The shorter travel – the shorter the movement of the button

Snap ratio

Snap ratio is expressed in Newton over millimetres (N/mm).

It measures the relation between force and travel, and shows how much you have to push the button **before it snaps** and makes contact with the underlying circuit.



Design guide takeaway:

- Steep curve: Provides sharp, defined clicks for high feedback.
- Gentle curve: Creates softer, smoother clicks.

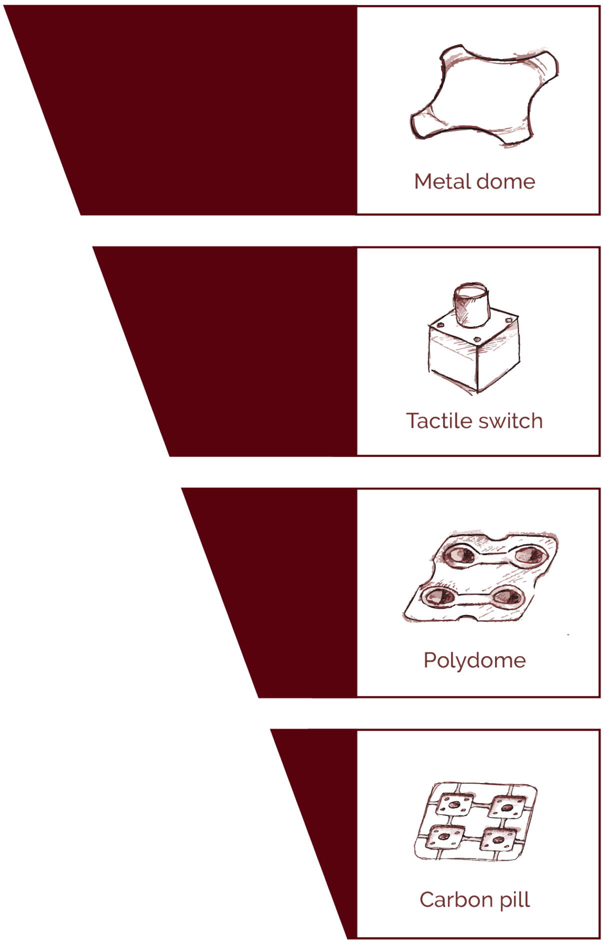
TACTILITY FACTOR
Audio

Audio feedback enhances both tactile and auditory experience.

Audio feedback is expressed in decibel (dB), and it explains **how much sound a button produces** when being pushed.

The illustration shows the range of options for achieving the required audio feedback.

With carbon pills you can achieve the lowest audio feedback. With metal domes you can achieve the highest audio feedback.

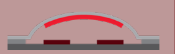


Design guide takeaway:
- Activation force and audio goes hand in hand.
- High activation force = high audio feedback.
- Low activation force = low audio feedback.

Tactility profiles for keypad designs

When tactility factors are combined with different click and material options, they create tactility profiles for the six most common keypad constructions.

These profiles help **evaluate and compare design options** for tactile feedback, based on extensive assessments and testing.

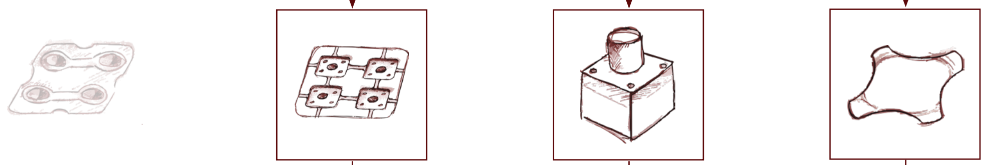
Keypad constructions		Tactility factors:			
		Force (N) (scale 0–5)	Travel (mm) (scale 0–5)	Snap ratio (N/mm) (scale 0–5)	Audio feedback (dB) (scale 0–5)
Silicone keypad with carbon pill		1–2	3–5	1–2	0–2
Silicone keypad with tactile switch		1.5–4	2–3	3–4	2–4
Silicone keypad with metal dome		2–5	2–3	2–4	2–4
Membrane keypad with polydome		1–2	1–3	1–2	1.5–4
Membrane keypad with tactile switch		1–2	1.5–2.5	1–2	2–4
Membrane keypad with metal dome		1–3	1.5–2.5	1.5–2.5	3–5

SCENARIO

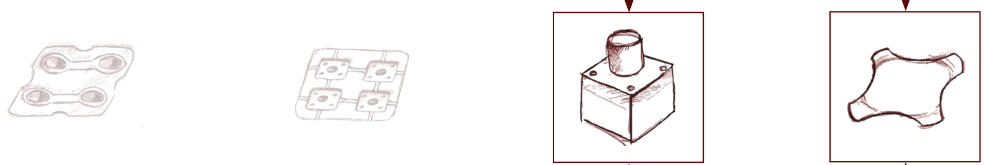
Good click for an industrial tool

This step-by-step guide helps translate customer requirements into a precise keypad specification. The solution: a silicone rubber keypad with metal domes to achieve a thin construction, a satisfying click feel, and distinct key shapes with clear audio and tactile feedback.

Requirements	**Tactility specification**
Used on a construction site Operated with gloves →	Multilevel button design, raised keys -> **silicone keypad**



Requirements	**Tactility specification**
Good click →	High audio feedback, activation force, and snap ratio -> **either metal domes or tactile switches**



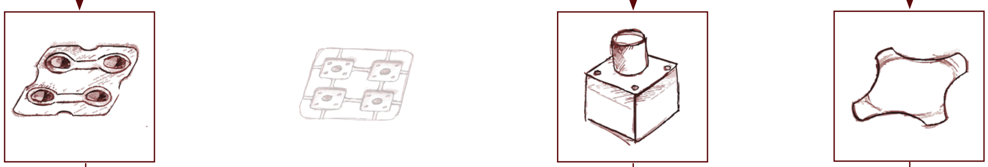
Requirements	**Tactility specification**
Front mounted keypad Housing recess 2 mm →	Thin construction -> **metal domes (600 g)**

SCENARIO

Ergonomic click for a medical device

This guide helps balance end-use requirements and tactility for HMIs in medical devices. Key needs include easy cleaning, precision controls, and frequent use in moist, warm environments. The solution: a membrane switch keypad with metal domes for long actuation life and reliable performance.

Requirements		Tactility specification
Medical environment Easy to clean	→	Seamless surface -> **membrane switch keypad with embossed keys**



Requirements		Tactility specification
Precision controlling High number of actuations	→	Mid snap ratio, low activation force (below 200g) -> **either polydomes or metal domes**

Requirements		Tactility specification
1 mio+ key actuations in moist environment with high temperature	→	High temperature resistance -> **metal domes with 1 mio+ actuation life**

Large distance from keys to PCB

A walk-through for selecting the right tactile keypad when the product's design places high demands on the keypad construction. The solution: a silicone rubber keypad with carbon pills, allowing for low audio feedback and long key travel to meet specific design constraints.

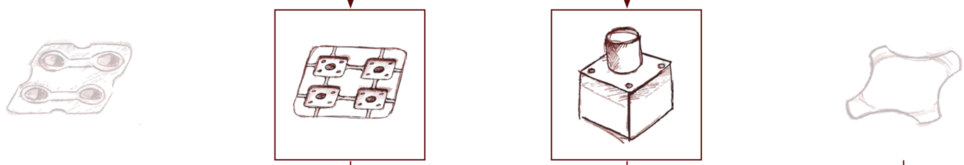
Requirements

Long distance between keypad (front side) and electrical layer (inside housing)

→

Tactility specification

Long travel, long actuation pin -> **either carbon pill or tactile switch**



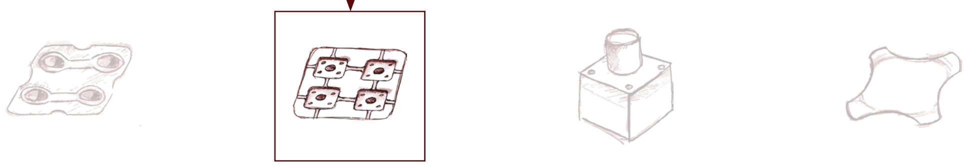
Requirements

Discreet keypad operation, low noise

→

Tactility specification

Low audio feedback -> **silicone rubber keypad with carbon pill**

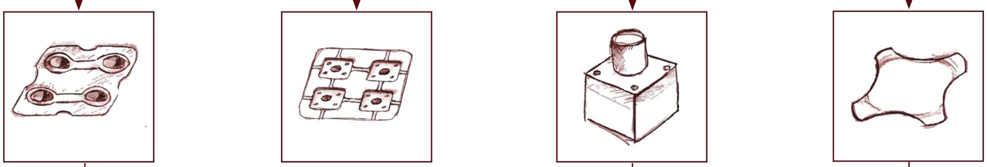


SCENARIO

Keypad with 40+ keys

This example shows how to achieve satisfactory performance, good tactile feedback, and cost efficiency. The solution: a membrane switch keypad with polydomes, offering low activation force and cost-effectiveness for designs with many buttons.

Requirements		Tactility specification
A full QWERTY keypad with letters and numbers for a control panel	→	All solutions are possible, though tactile switch and metal dome increase the cost.



Requirements		Tactility specification
Easy to type on keypad	→	Low actuation force -> **polydomes or metal domes**

Requirements		Tactility specification
Used in an indoor environment with normal temperature levels	→	With a large number of buttons, the optimal solution is **membrane switch with polydomes**

SCENARIO

Keypad with many LEDs

Step-by-step guide to keypad design with multiple LEDs. To reduce high soldering costs, integrate components in the same process. The solution: a silicone keypad with high actuation force to prevent misactuation, using a tactile switch for cost efficiency.

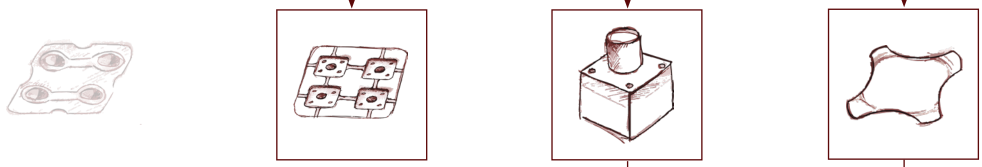
Requirements

A keypad with 20+ LEDs and an on-board LED-driver and few buttons

→

Tactility specification

PCB is necessary -> **either carbon pill, tactile switch or metal dome.**



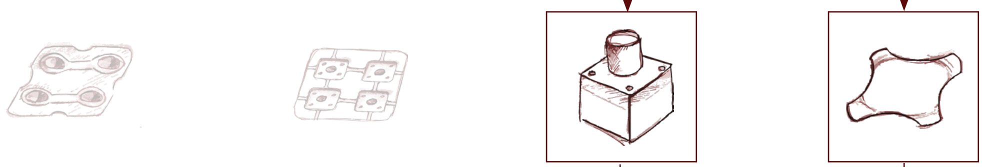
Requirements

Avoid misactuation of keys

→

Tactility specification

Design of keys so misactuation is avoided -> **silicone keypad with high actuation force (~500 g)**



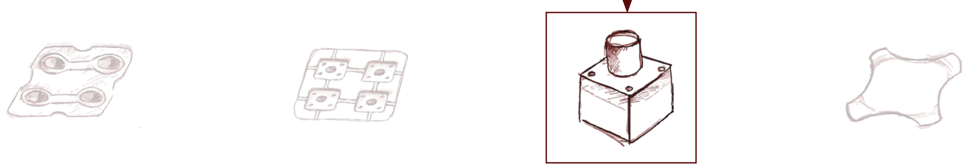
Requirements

Complete HMI module with PCB, plastic front housing and keypad

→

Tactility specification

Click component soldered alongside LEDs (cost-efficiency) -> **Tactile switch (~500g)**



Design guidelines

- **Balance the four tactility factors**
  Ensure an optimal balance between force, travel, snap ratio, and audio feedback for a satisfying and functional user experience.

- **Match the tactility to the use case**
  Consider environmental conditions, user interaction (e.g., gloves, precision input), and industry standards when choosing keypad specifications.

- **Choose the right click component**
  Select among metal domes, tactile switches, carbon pills, or polydomes based on durability, actuation force, and feedback needs.

- **Consider the impact of keypad construction**
  Silicone keypads offer longer travel and softer feedback, while membrane keypads provide shorter, sharper clicks—choose accordingly.

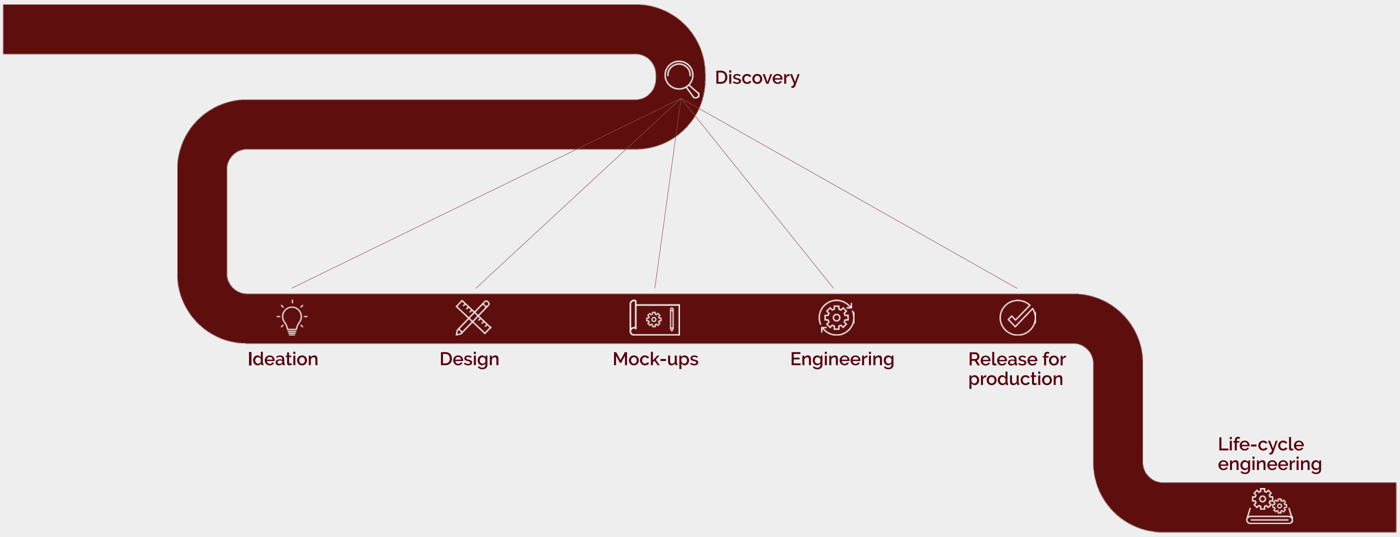
- **Control audio feedback based on environment**
  High audio feedback is useful for industrial tools but may be distracting in medical and office environments—adjust accordingly.

- **Ensure click clarity and avoid misactuation**
  If precise control is needed, select a higher snap ratio for sharper clicks. To prevent accidental presses, opt for higher actuation force.

HMI design services

We offer design and engineering services for your HMI solution. Whether you're facing time constraints, resource limitations, or simply need specialised HMI expertise, our specialists are ready to integrate into your development efforts seamlessly.

Our HMI services are structured into distinct development stages, allowing you to select and purchase service packages tailored to your current needs. This modular approach ensures you get exactly the support you require, when you need it.



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