

FUNCTION STRUCTURE DIAGRAM

ASSIGNMENT-4

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STEP 1 AND 2 : FUNCTIONS & FLOWS

Material Flow

Input material flow : Components and Parts

The chair receives various parts during the manufacturing process including metal frames, plastic components, foam padding, and fabric upholstery.

Output material Flow : An Assembled chair

Components are assembled to form the complete ergonomic chair.

1

Input flow : Upholstery Material

Fabric or leather materials are supplied to cover the chair's seat, backrest, and armrests.

Output Flow : Upholstered Chair

Upholstery materials are applied to the chair's frame, providing a comfortable and aesthetically pleasing surface.

2

Input flow : Foam Padding

Foam padding materials are integrated into the chair's seat and backrest to provide cushioning and support.

Output flow : Padded Chair

Foam padding is integrated with the chair's structure, providing comfort and support for the user.

Information Flow

Input information flow : *User Preferences*

User preferences regarding chair settings, such as seat height, armrest position, and recline angle, are received by the chair's control mechanism given by user.

Output information flow : *Customized Chair Configuration*

The chair adjusts its settings based on user preferences, providing a customized seating experience.

1

Input flow : Body Posture

Sensors can detect the user's body posture and movements while seated, providing feedback to the chair's adjustment mechanism.

Output Flow : Optimized Seating Position

The chair adapts its settings to optimize the user's posture and comfort, promoting ergonomic seating.

User must have
knows' & how's of
correct sitting
posture

2

Input flow : User Feedback

User feedback regarding comfort, adjustability, and overall satisfaction with the chair is processed by the chair's onboard computer or control system.

Output flow : *User feedback is utilized to improve future iterations of the chair's design, addressing usability issues and enhancing user experience*

Energy Flow

1

Input energy flow : *Electrical Energy*

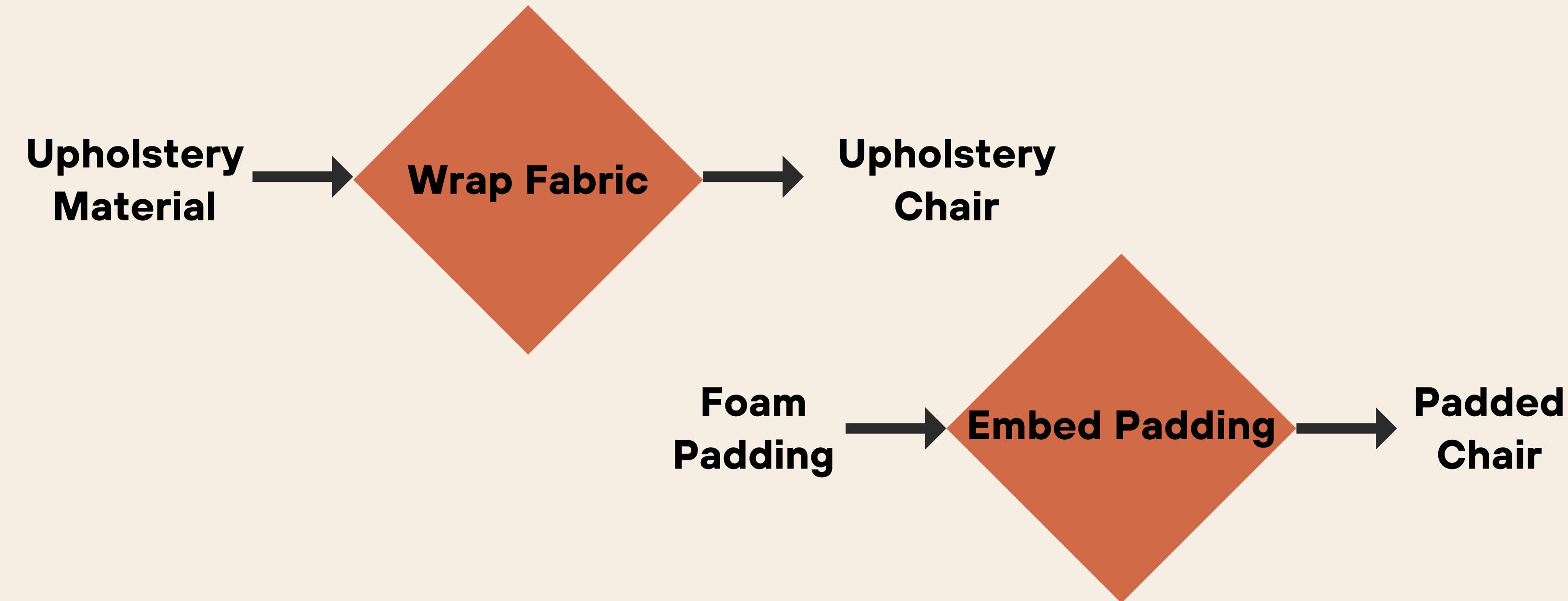
Electrical energy is supplied to power the chair's adjustable features, such as motorized height adjustment, recline mechanism, and heating elements.

Output energy flow : *Powered Chair Functions*

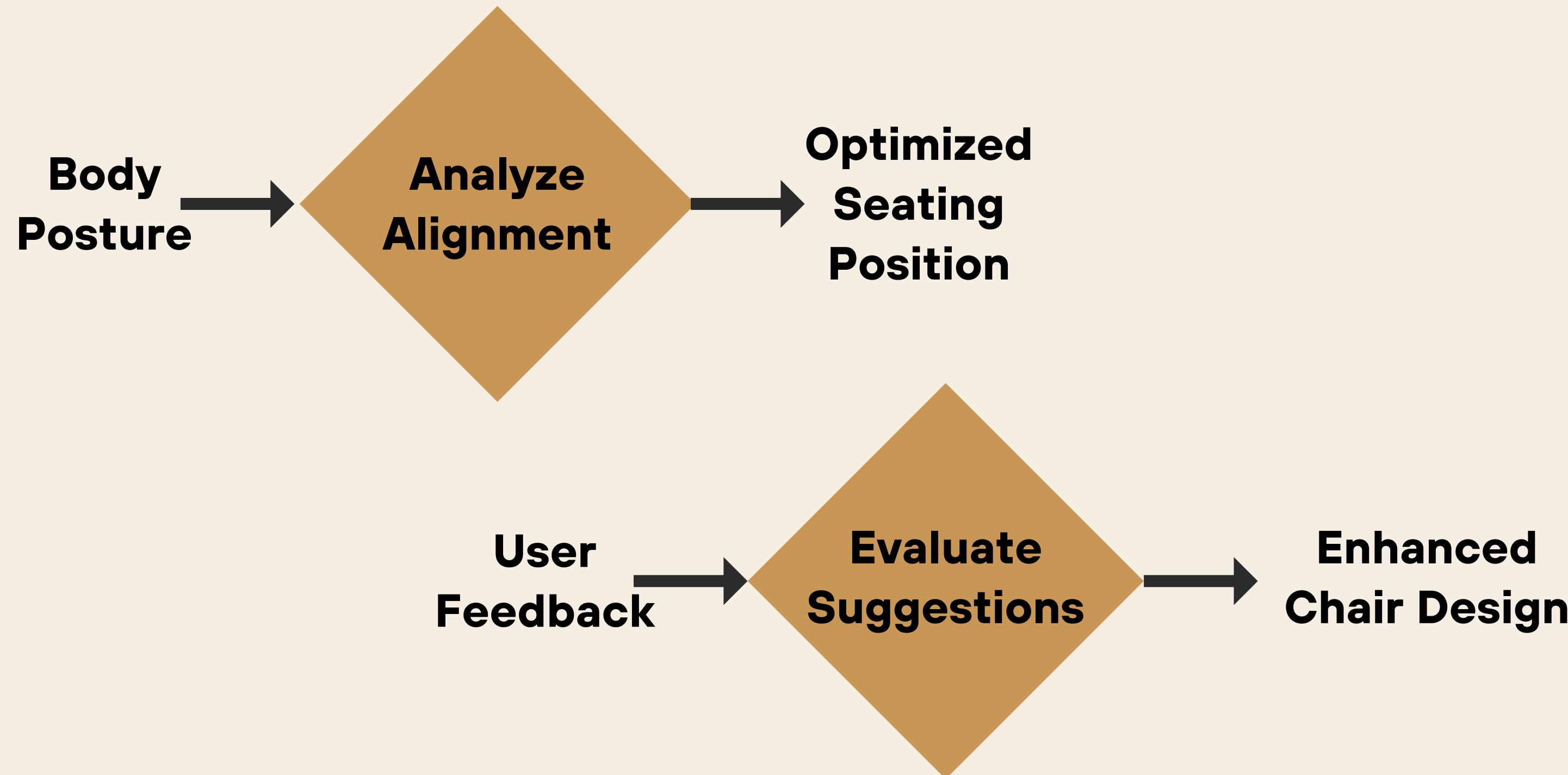
Electrical energy powers the chair's adjustable features, enabling smooth operation and customization for the user.

STEP2: CREATING A BLACK BOX MODEL

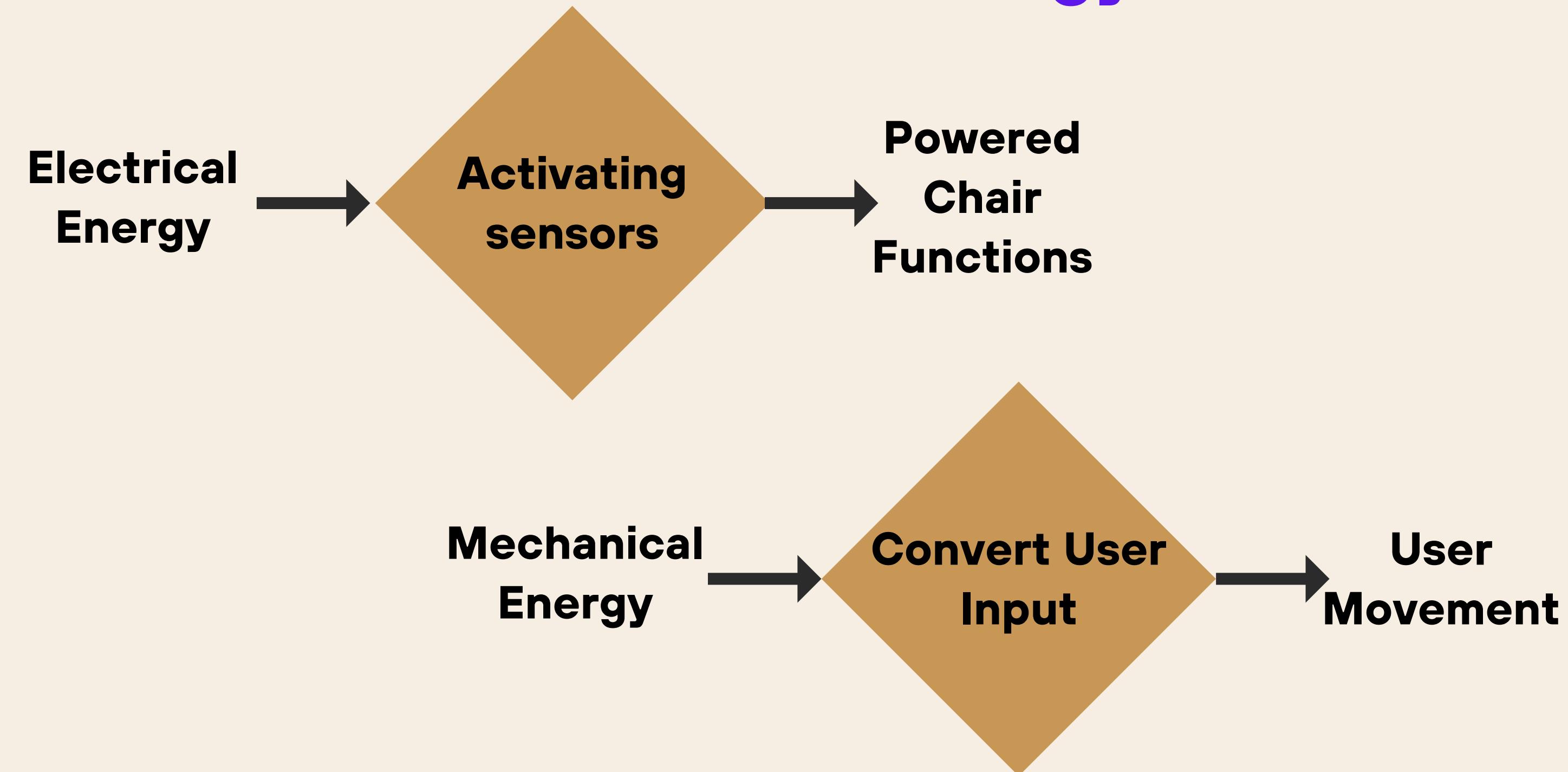
Material Flow



Information Flow

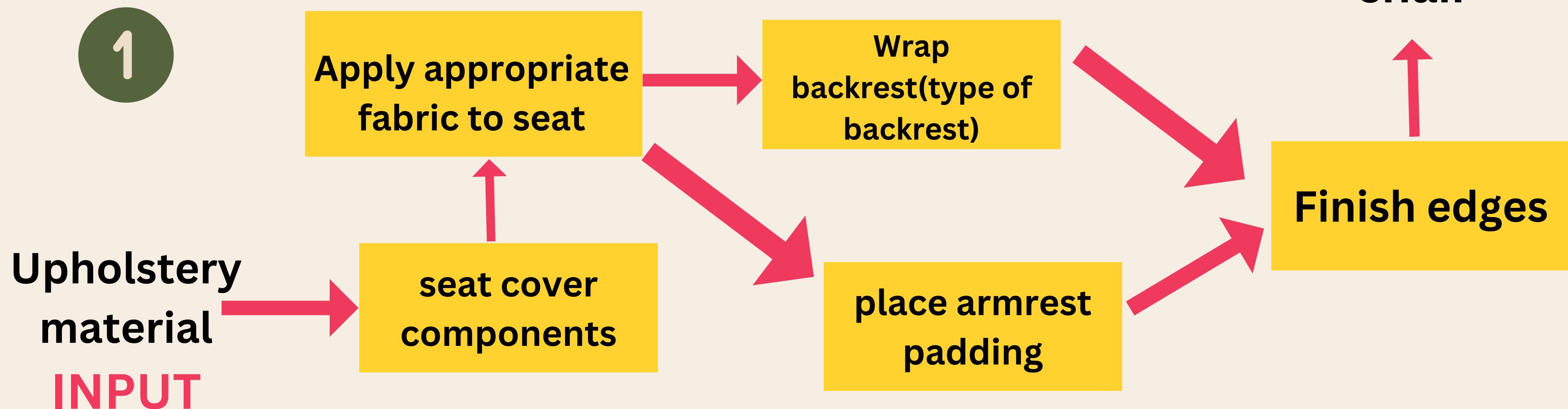


Energy Flow



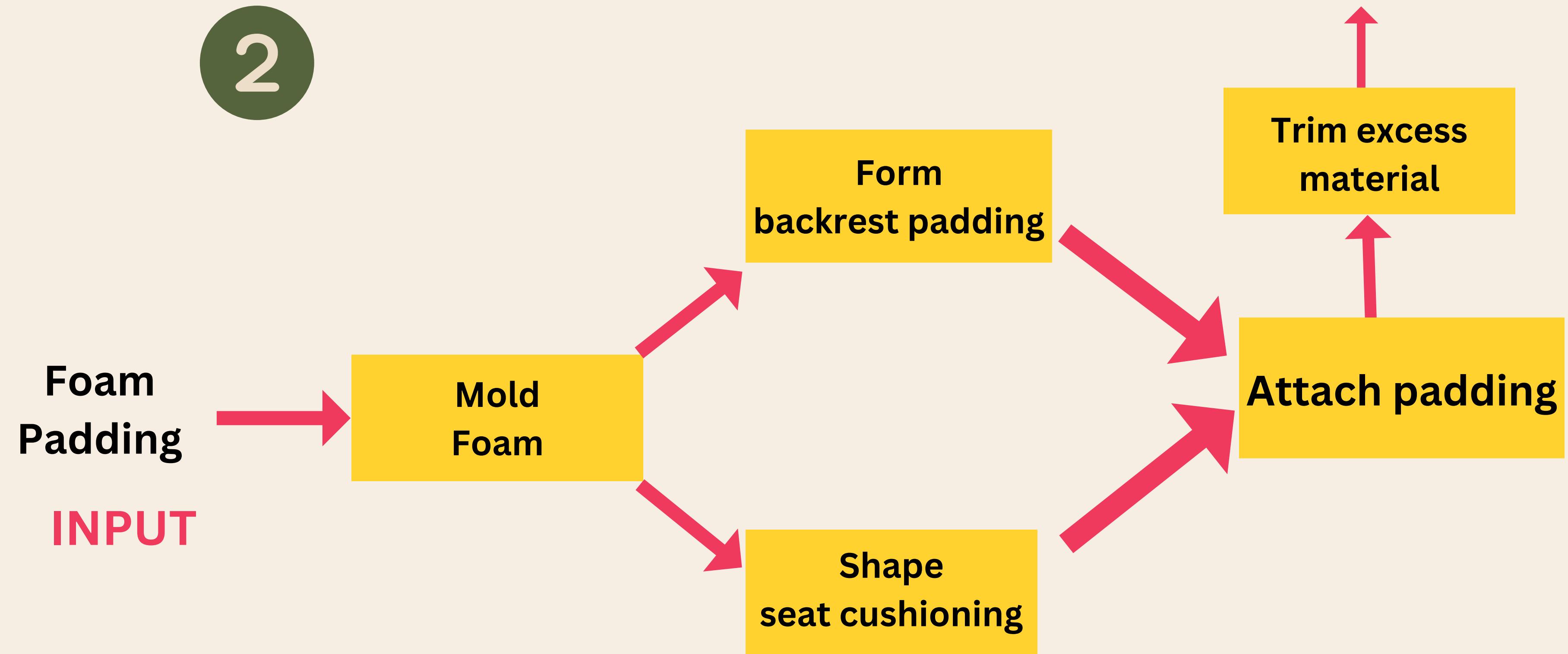
STEP 3: TRACING FLOWS

Tracing flow for materials



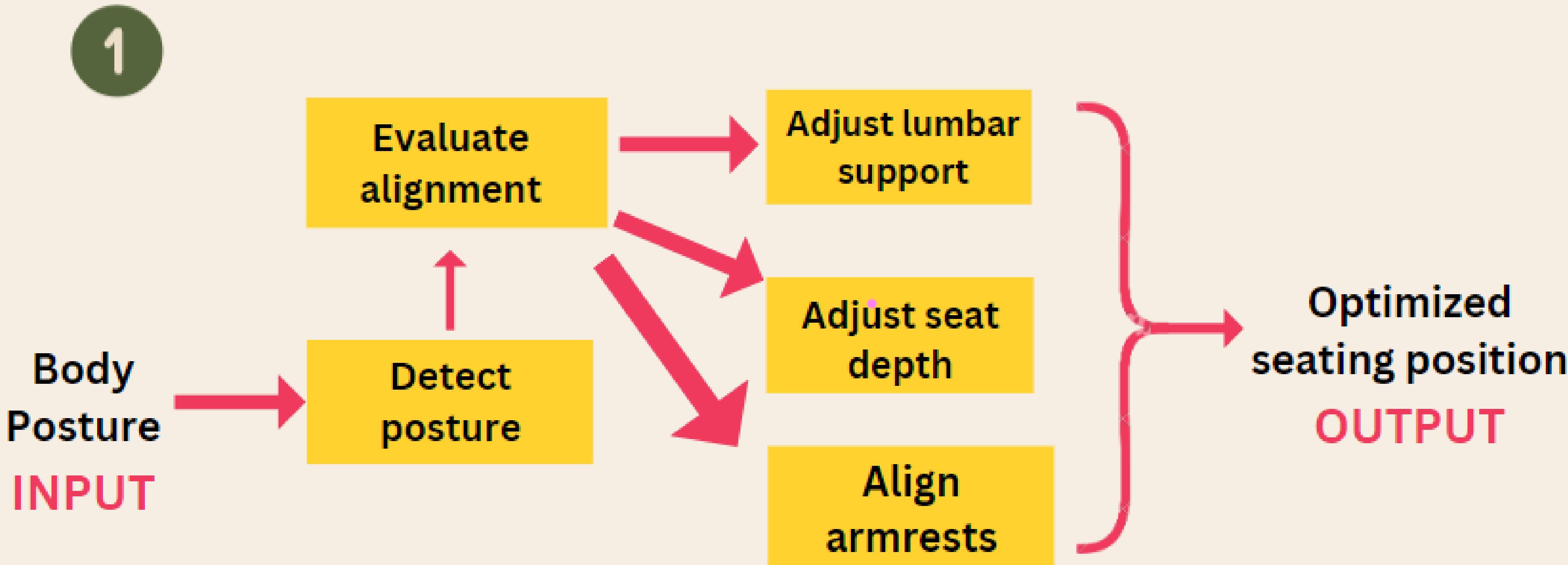
OUTPUT

Padded chair

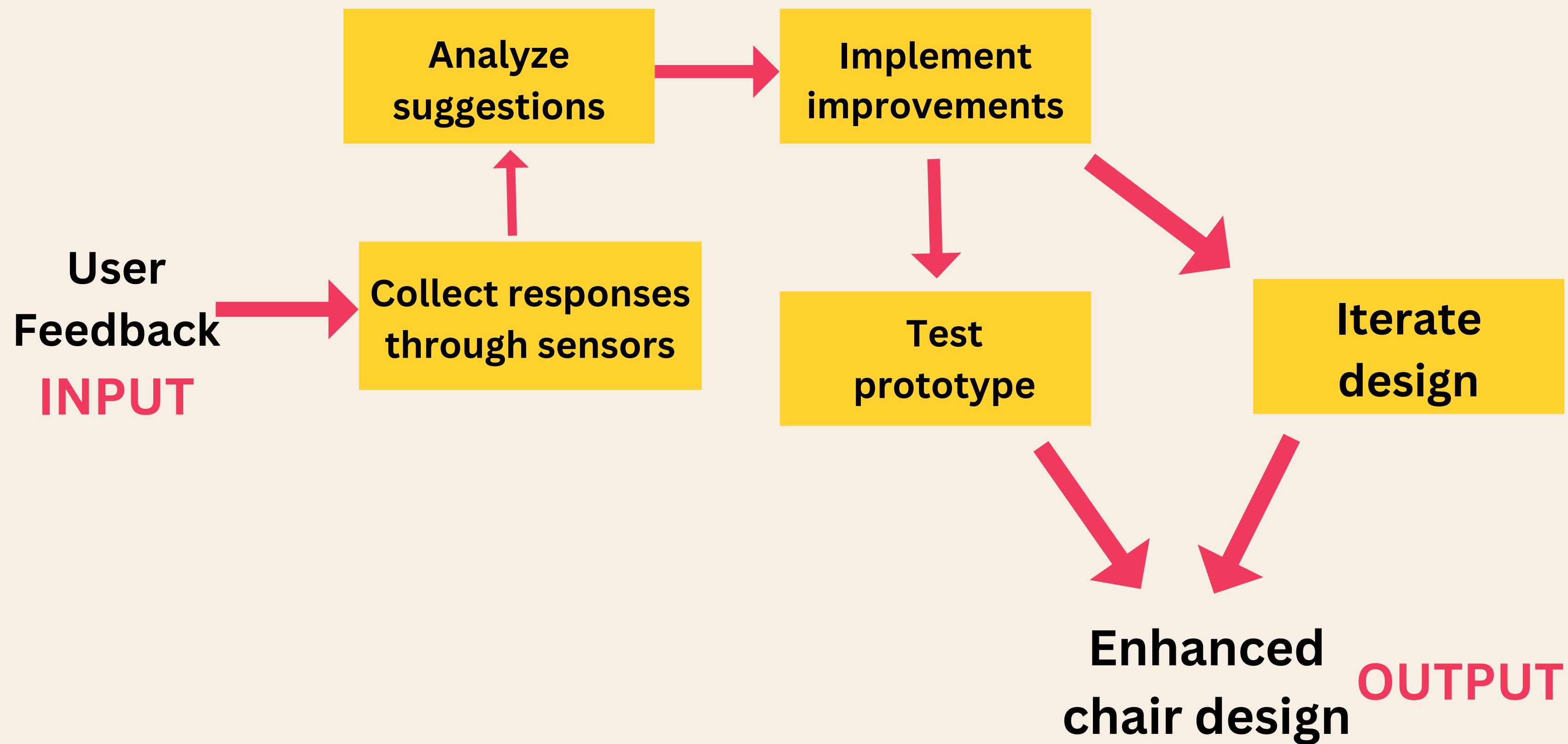


2

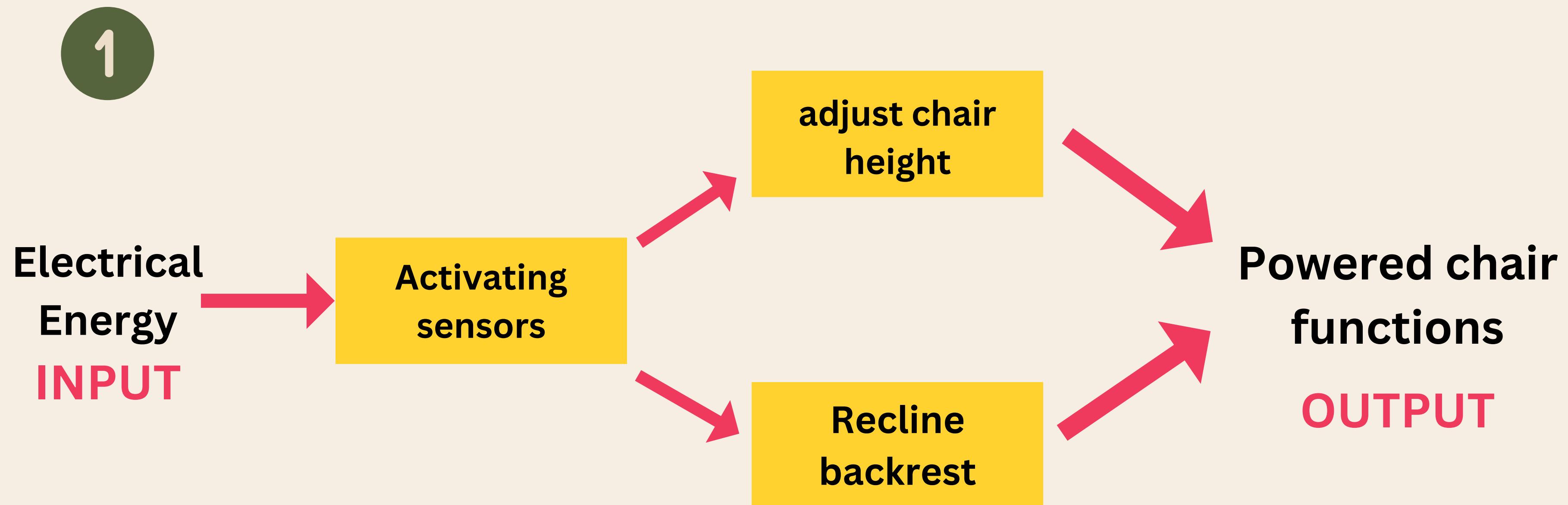
Tracing flow for information



2

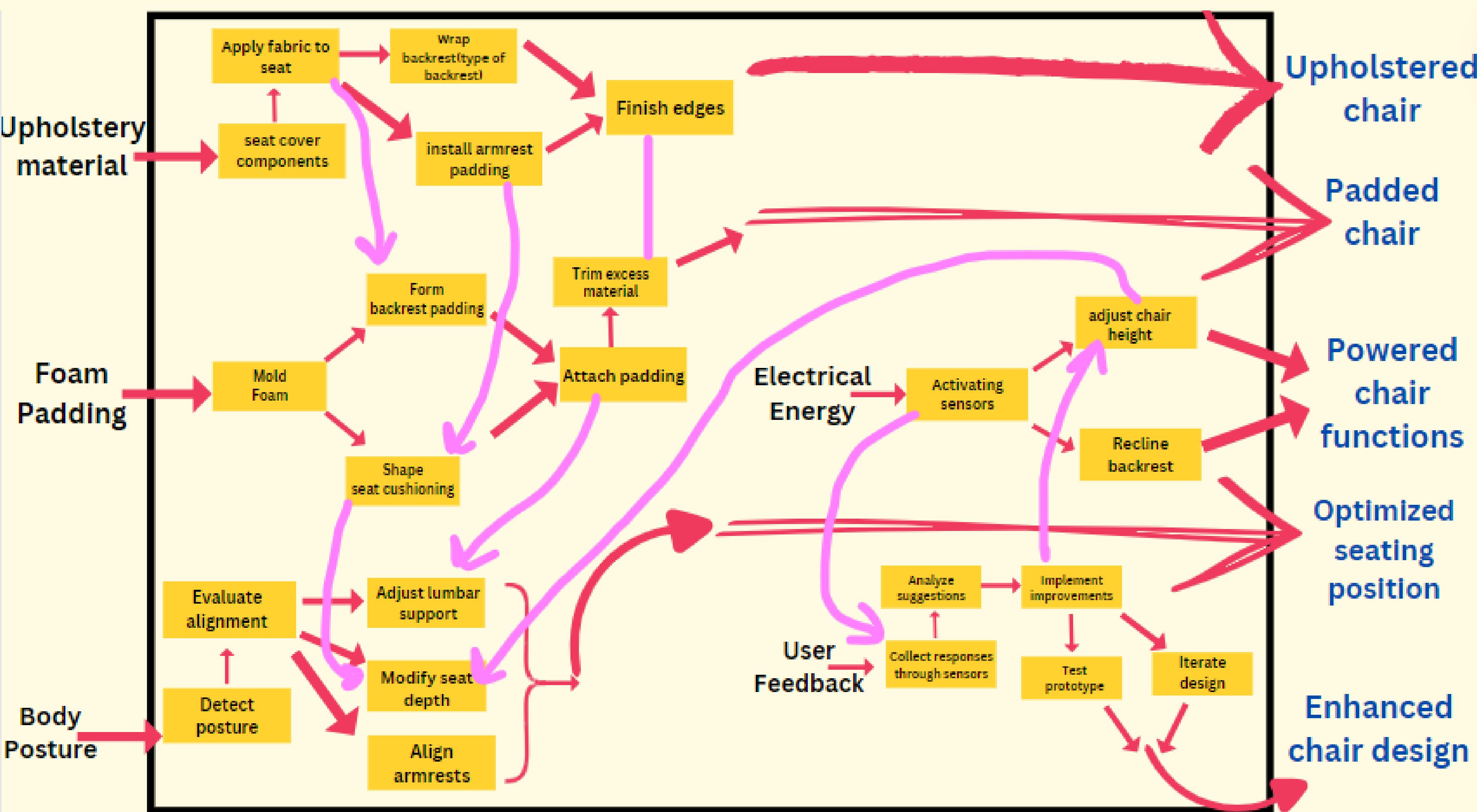


Tracing flow for energy.



STEP 4: ASSEMBLING THE TRACES AND SELECTING THE BOUNDARY

- For input
- For output
- For connecting lines



STEP5: REVIEWING AND REVISING OUR FSD

QUES1] Do the inputs and outputs of your final FSD agree with the inputs and outputs of your original black box diagram?

Yes, the inputs and outputs identified in the final FSD align with those outlined in the original black box diagram. Inputs such as upholstery material, foam padding, user preferences, body posture, electrical energy, and mechanical energy, along with outputs like upholstered chair, padded chair, customized chair configuration, optimized seating position, powered chair functions, and user movement, are consistent with the original diagram.

QUES2]What assumptions were made by your choice of input flows, output flows, and system boundaries?

Assumptions include the availability of materials, user preferences for customization, and the chair's ability to adapt to various body postures. Additionally, assumptions may have been made regarding the chair's energy sources and compatibility with standard electrical outlets. These assumptions are necessary for defining the scope and functionality of the ergonomic chair.

QUES3] Are these assumptions appropriate for project? Are they documented in your design brief?

The assumptions regarding **input flows, output flows, and system boundaries** have been appropriate for the project and aligned with the objectives outlined in the design brief are explicitly documented in the design brief to provide clarity and transparency.

QUES4] Are all of the harmful, unintended, or unwanted output flows documented?

Yes, FSD includes documentation of **undesirable output flows such as heat and noise, ensuring potential negative impacts** of chair's operation are considered and addressed in the design process.

QUES5] Do your assumptions align with your design brief?

Yes, our assumptions have aligned with the objectives and scope outlined in the design brief to ensure **consistency and coherence in project planning and execution.**

QUES6] Does the boundary of FSD communicate the scope of the project described in the design brief?

Yes, boundary of the FSD has clearly delineated the scope of the project as described in the design brief, specifying the inputs, outputs, and system components relevant to the ergonomic chair design.

QUES7] Are all Functions solution-neutral?

Yes, all functions outlined in the FSD describe what must be done rather than prescribing specific solutions, allowing flexibility in implementation and encouraging creativity in design approaches.

QUES8] Can any of the functions be broken down into simpler functions?

No, we have tried to create as simpler and atomic subfunctions for our ergonomic chair.

QUES9] Would the user benefit from output signals that confirm correct operation of the device?

Yes, providing output signals to indicate successful completion of tasks, such as adjusting settings or achieving optimal posture, enhance the user experience. User feedback guide the inclusion of such features , ensuring usability and satisfaction.

IDEA GENERATION STAGE: BRAINSTORMING

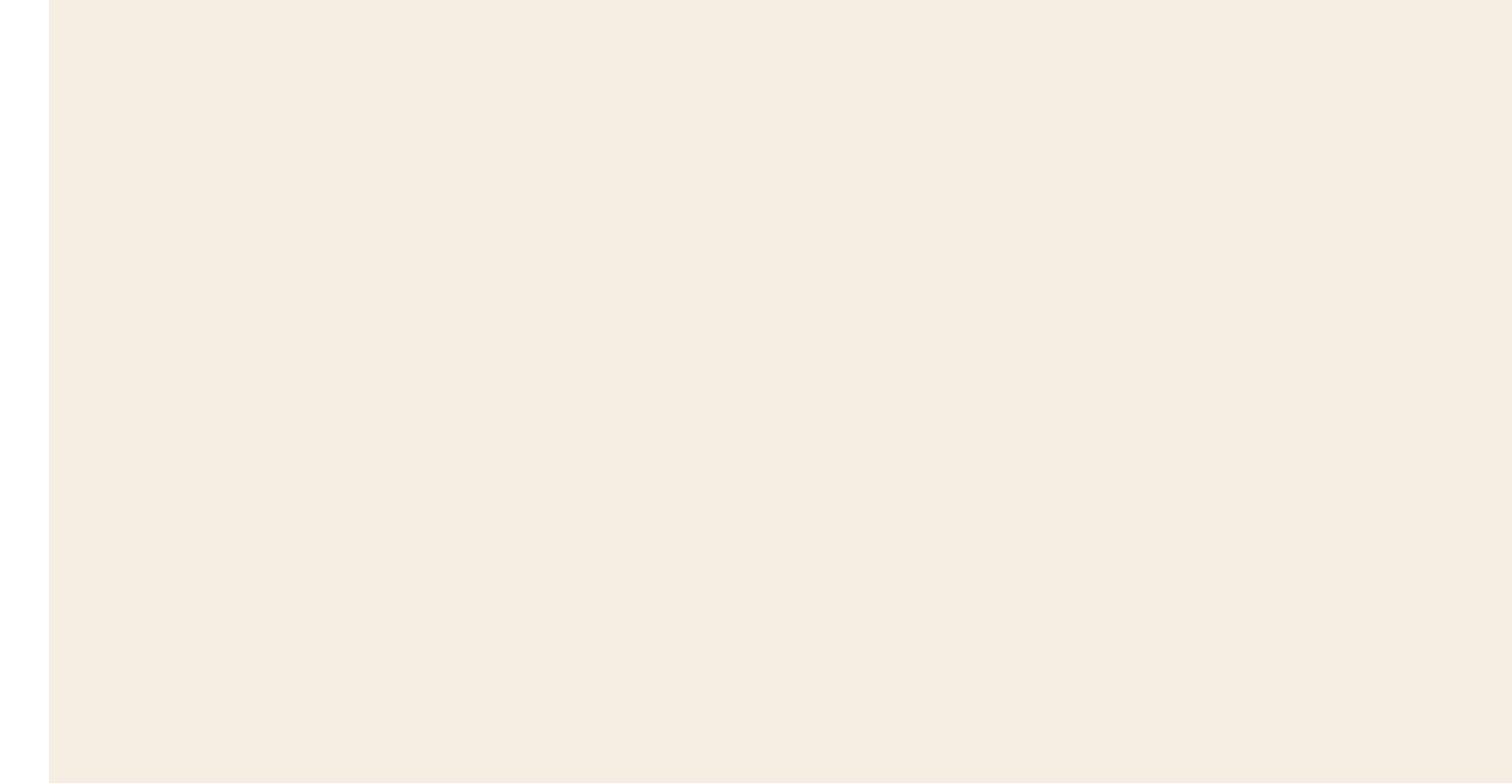
Please Visit:

<https://docs.google.com/document/d/1fjpYlqrCaltuoG72ZAC1dawg0CSP4WOW4POhjTZEYxE/edit>



Wrap Backrest:

- a. Use a seamless wrapping technique for a sleek appearance.[\[a11\]](#)
- b. Experiment with different fabrics to find the most comfortable and durable option. [\[a12\]](#)
- c. Integrate adjustable tension straps to provide customizable lumbar support. [\[a13\]](#)
- d. **Explore a motorized headrest that adjusts seamlessly for personalized neck support, catering to various user heights and preferences.**[\[a14\]](#)
- e. Add a breathable mesh panel to improve air circulation.
- f. Explore ergonomic contours to better fit the natural curve of the spine.
- g. Offer removable and washable backrest covers for easy maintenance.
- h. Implement a heat-resistant material for users who prefer heated backrests.[\[a15\]](#)
- i. Introduce a massage feature for added relaxation and muscle relief.[\[a16\]](#)
- j. Include built-in lumbar massagers to alleviate back pain and tension.[\[a17\]](#)



Install Armrest Padding:

- a. Use gel-infused memory foam for superior comfort and pressure relief.[\[a21\]](#)
- b. Offer adjustable armrest padding to accommodate different arm lengths.
- c. Design armrests with contoured shapes to support natural arm positions.[\[a22\]](#)
- d. Experiment with textured materials for a non-slip grip.[\[a23\]](#)
- e. Integrate cooling gel technology to prevent armrests from getting too hot.
- f. **Design adjustable armrests with intuitive controls, allowing users to find the perfect height and angle for ergonomic arm support during extended periods of sitting**[\[a24\]](#)
- g. Include built-in wrist supports to prevent carpal tunnel syndrome.
- h. Implement adjustable width armrests to suit users with broader shoulders.[\[a25\]](#)
- i. Offer armrest padding with built-in USB ports for convenient device charging.[\[a26\]](#)
- j. Explore eco-friendly and sustainable materials for armrest padding.[\[a27\]](#)

Adjust Lumbar Support:

- a. Develop a motorized lumbar support system with customizable settings.
- b. Integrate a sensor-based system that automatically adjusts lumbar support based on user posture.[\[a31\]](#)
- c. Offer manual adjustment options for users who prefer more control.[\[a32\]](#)
- d. **Develop a lumbar support system with customizable firmness levels, ensuring optimal spinal alignment and comfort for users of all sizes..**[\[a33\]](#)
- e. Provide memory settings to save preferred lumbar support configurations.
- f. Implement a heat therapy feature to soothe and relax the lower back muscles.[\[a34\]](#)
- g. Include visual indicators to guide users in finding the optimal lumbar support position.[\[a35\]](#)
- h. Offer lumbar support cushions with built-in massage functions for added comfort.[\[a36\]](#)
- i. Explore sustainable materials for lumbar support components to align with eco-friendly initiatives.[\[a37\]](#)

Adjust Seat Depth:

- a. **Develop a sliding seat mechanism that allows for easy adjustment of seat depth.**[\[a41\]](#)
- b. Implement an adjustment system for effortless seat depth customization.[\[a42\]](#)
- c. Offer manual adjustment options for users who prefer more control.[\[a43\]](#)
- d. Experiment with different seat cushion shapes to accommodate various thigh lengths.[\[a44\]](#)
- e. Provide visual indicators to guide users in finding the optimal seat depth position.
- f. Integrate a leg support feature that extends and retracts smoothly, providing customizable comfort for users to elevate and relax their legs as needed..[\[a45\]](#)
- g. Offer seat depth adjustment levers that are easily accessible and intuitive to use.[\[a46\]](#)
- h. Implement a pressure-sensitive system that automatically adjusts seat depth based on user weight distribution.[\[a47\]](#)

Recline Backrest:

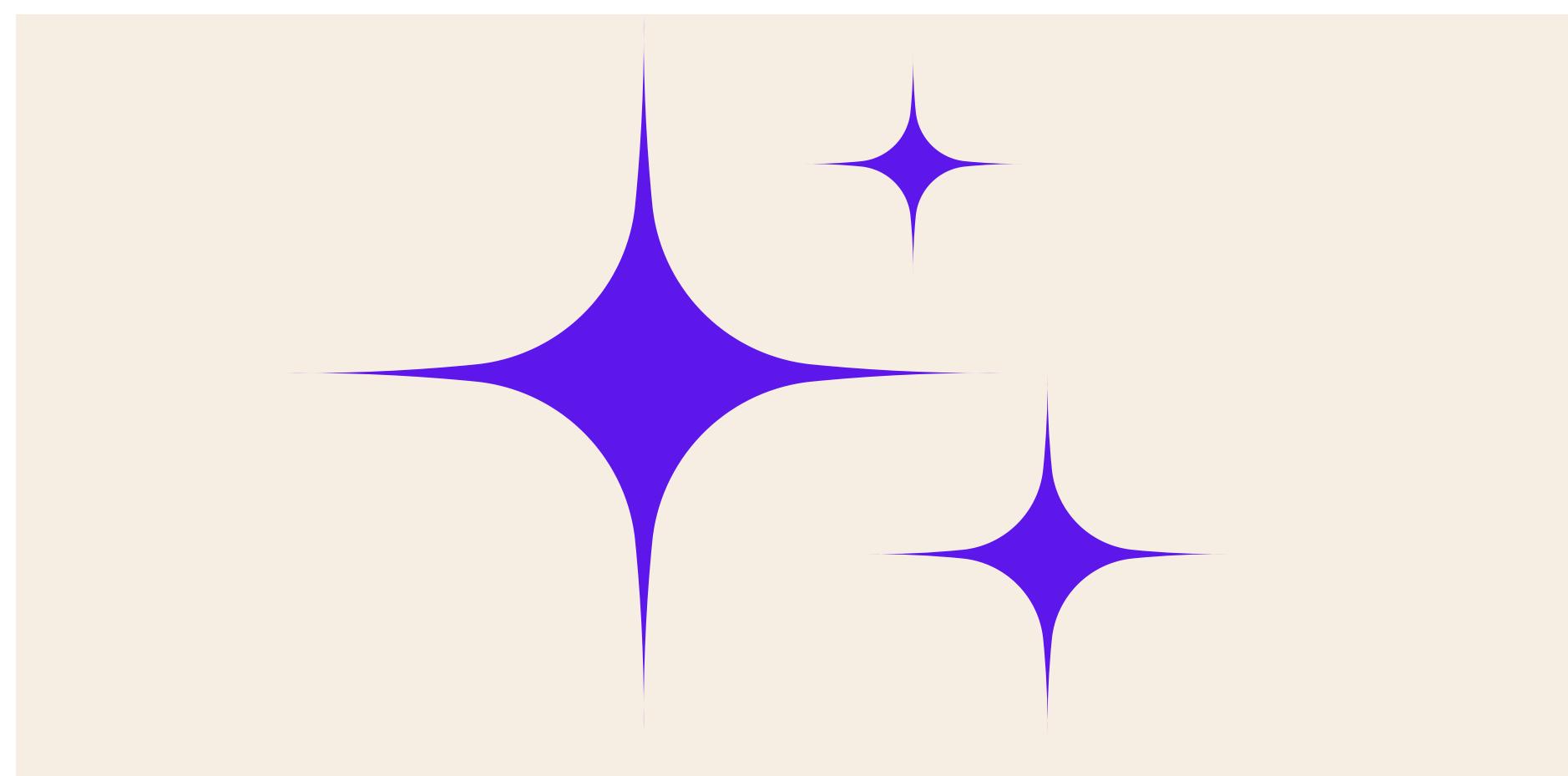
- a. Develop a multi-position reclining mechanism with a wide range of angles for personalized comfort.[a51]
- b. Integrate a tension adjustment feature to control the resistance when reclining.
- c. Implement a synchronized reclining system that adjusts the seat and backrest simultaneously.[a52]
- d. **Include a built-in footrest that extends when the backrest reclines for full-body support.[a53]**
- e. Experiment with different recline angles to find the most ergonomic and comfortable positions.[a54]
- f. Provide memory settings to save preferred recline configurations.[a55]
- g. Integrate lumbar support adjustments that are synchronized with the recline angle.[a56]
- h. Implement a heat therapy feature in the backrest to soothe muscles during recline.[a57]

Adjust Chair Height:

- a. Implement height adjustment mechanism for effortless customization.[a71]
- b. Offer a wide range of height settings to accommodate users of different heights.[a72]
- c. Integrate memory settings to save preferred chair height configurations.
- d. Provide visual indicators to guide users in adjusting the chair to the correct height.[a73]
- e. **Offer manual height adjustment options for users who prefer more control.[a74]**
- f. Include a foot pedal or lever for easy access to the height adjustment mechanism.[a75]
- g. Experiment with different chair base designs to ensure stability at various heights.[a76]
- h. Implement a weight-sensitive system that automatically adjusts chair height

Shape Seat Cushioning:

- a. Utilize high-density memory foam for long-lasting support and comfort.[a61]
- b. Offer contoured seat cushions to distribute weight evenly and reduce pressure points.[a62]
- c. Integrate gel-infused cushions for enhanced cooling and comfort.
- d. Experiment with different seat shapes to accommodate various body types and sitting preferences.[a63]
- e. Provide removable and washable seat covers for easy maintenance and hygiene.[a64]
- f. **Create a comfort seat with foam density calibrated to the ILD Standard, offering consistent support and cushioning tailored to individual preferences for prolonged comfort during seating.[a65]**
- g. Offer seat cushions with built-in vibration massage functions for added relaxation.
- h. Implement adjustable firmness settings to cater to individual preferences.[a66]
- i. Explore sustainable materials such as bamboo or recycled foam for eco-friendly seat cushioning.



INSIGHTS FROM BRAINSTORMING

Wrap Backrest:

The brainstorming process explored various methods of wrapping the backrest to ensure both comfort and aesthetic appeal. Ideas ranged from **seamless wrapping techniques** to the use of different fabrics and materials to enhance user experience. The goal was to find innovative ways to provide support while also considering visual design and user preferences.

Install Armrest Padding:

Brainstorming focused on enhancing armrest comfort through the use of advanced materials and ergonomic design. Ideas included **gel-infused memory foam**, **adjustable padding options**, and innovative features such as built-in wrist supports and device charging capabilities. The aim was to prioritize user comfort and convenience while addressing potential ergonomic issues.

Adjust Lumbar Support:

The brainstorming process aimed to optimize lumbar support for users by exploring various adjustment mechanisms and technologies. Ideas ranged from **motorized lumbar support systems** to **sensor-based automatic adjustments**. Consideration was given to factors such as **customization options**, **comfort levels**, and **ease of use** to ensure an ergonomic solution.

Adjust Seat Depth:

Brainstorming focused on developing a seat depth adjustment mechanism that provides personalized comfort and support. Ideas included **sliding seat mechanisms**, **pneumatic adjustments**, and **pressure-sensitive systems**. The goal was to offer users flexibility in adjusting seat depth to accommodate different body types and sitting preferences.



INSIGHTS FROM BRAINSTORMING

Recline Backrest:

The brainstorming process explored ways to enhance the reclining functionality of the backrest for maximum comfort and relaxation. Ideas included multi-position reclining mechanisms, zero-gravity recline options, and integrated footrests. Consideration was given to features such as lumbar support, heat therapy, and synchronization with other adjustments to provide a comprehensive reclining experience.

Shape Seat Cushioning:

Brainstorming focused on shaping seat cushions to optimize comfort and support for users. Ideas included utilizing high-density memory foam, contoured designs, and cooling gel technology. Consideration was given to factors such as breathability, durability, and sustainability to ensure an ergonomic and eco-friendly solution.

Adjust Chair Height:

The brainstorming process explored various methods of adjusting chair height to accommodate users of different heights and preferences. Ideas included pneumatic height adjustment mechanisms, manual options, and weight-sensitive systems. Consideration was given to factors such as stability, accessibility, and ease of use to ensure a user-friendly solution.

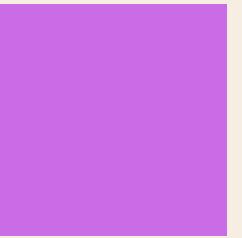


MORPHOLOGICAL CHART

Wrap backrest	a11	a12	a13	a14	a15	a16	a17
Install armrest padding	a21	a22	a23	a24	a25	a26	a27
Place lumbar support	a31	a32	a33	a34	a35	a36	a37
Adjust seat depth	a41	a42	a43	a44	a45	a46	a47
Recline backrest	a51	a52	a53	a54	a55	a56	a57
Seat cushioning	a61	a62	a63	a64	a65	a66	a67
Adjust chair height	a71	a72	a73	a74	a75	a76	a77

a11-a77 are the ideas from brainstorming from the below document

<https://docs.google.com/document/d/1fjpYlqrCaltuoG72ZAC1dawgOCSP4WOW4POhjTZEYxE/edit>



Concept1 = $a_{14} + a_{24} + a_{33} + a_{41} + a_{53} + a_{65} + a_{74}$



Concept2 = $a_{16} + a_{27} + a_{34} + a_{42} + a_{54} + a_{67} + a_{71}$



Concept3 = $a_{17} + a_{25} + a_{36} + a_{43} + a_{51} + a_{63} + a_{76}$



Concept4 = $a_{11} + a_{22} + a_{37} + a_{44} + a_{52} + a_{62} + a_{75}$



Concept5 = $a_{12} + a_{23} + a_{35} + a_{47} + a_{56} + a_{66} + a_{77}$

KEY CONCEPTS FROM MORPHOLOGICAL CHART

Concept 1 : Explore a motorized headrest that adjusts seamlessly for personalized neck support, catering to various user heights and preferences

Concept 2 : Develop a lumbar support system with customizable firmness levels, ensuring optimal spinal alignment and comfort for users of all sizes

Concept 3 : Design adjustable armrests with intuitive controls, allowing users to find the perfect height and angle for ergonomic arm support during extended periods of sitting

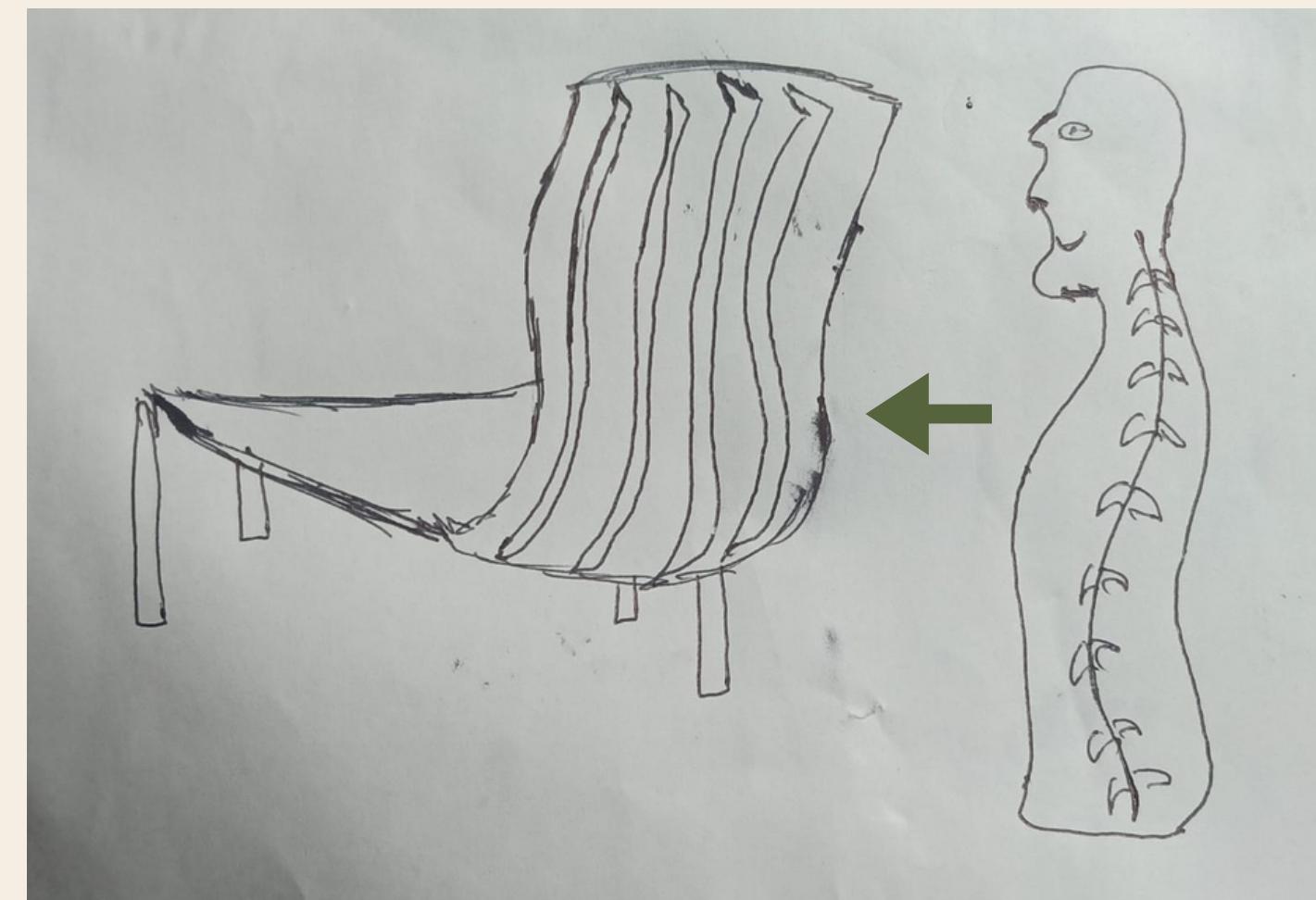
Concept 4 : Include a built-in footrest that extends when the backrest reclines for full-body support

Concept 5 : Create a comfort seat with foam density calibrated to the ILD Standard, offering consistent support and cushioning tailored to individual preferences for prolonged comfort during seating

BID(Biologically Inspired Design / Biomimetics / Biomimicry)

(1) Chair Back with Spine-Inspired Support Panels

Concept : This chair back design incorporates segmented support panels inspired by the human spine to provide optimal lumbar support while adapting to different sitting postures.

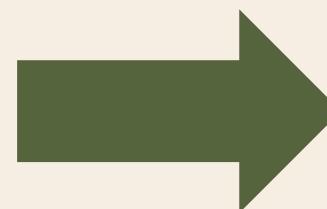


(2) Chair Armrests Inspired by Bird Wings

Concept : Inspired by the incredible flexibility and range of motion of a bird's wing, this design proposes adjustable armrests for chairs that adapt to different arm positions and activities.

Idea of Sketch: The armrest connects to the chair frame with a strong, multi-directional hinge system. This hinge allows for movement in several planes.

The top surface of the armrest would be a comfortable, padded surface that mimics the shape of a bird's wings. It could be slightly angled for optimal wrist and arm comfort.



SCAMPER

Concept 1: Explore a motorized headrest that adjusts seamlessly for personalized neck support, catering to various user heights and preferences

Substitute: Substitute the motorized headrest with a pneumatic headrest that adjusts based on user weight.

Combine: Combine the motorized headrest with a built-in massager for neck and shoulder relaxation.

Adapt: Adapt the motorized headrest to include a memory function that remembers user preferences for height and angle.

Modify: Modify the motorized headrest to include adjustable vibration intensity for customizable massage settings.

Put to another use: Use the motorized headrest mechanism to adjust other parts of the chair, such as the lumbar support or armrests.

Eliminate: Eliminate the motorized aspect of the headrest and replace it with a manual adjustment lever to reduce complexity and cost.

Reverse: Reverse direction of adjustment for the motorized headrest, allowing users to adjust it from a lying position.

SCAMPER

Concept 2: Develop a lumbar support system with customizable firmness levels, ensuring optimal spinal alignment and comfort for users of all sizes

Substitute: Substitute the lumbar support system with an air-filled lumbar cushion for adjustable support.

Combine: Combine the lumbar support system with a posture sensor that provides feedback on user sitting habits.

Adapt: Adapt the lumbar support system to include heat therapy functionality for soothing lower back muscles.

Modify: Modify the lumbar support system to include adjustable width settings for personalized support.

Put to another use: Use the lumbar support system as a standalone cushion for use in other chairs or seats.

Eliminate: Eliminate the customizable firmness levels and instead offer preset firmness options to simplify the design.

Reverse: Reverse the direction of adjustment for the lumbar support system, allowing users to adjust it from the front of the chair.

SCAMPER

Concept 3: Design adjustable armrests with intuitive controls, allowing users to find the perfect height and angle for ergonomic arm support during extended periods of sitting

Substitute: Substitute the adjustable armrests with inflatable armrests that can be inflated or deflated to adjust height and angle.

Combine: Combine the adjustable armrests with built-in cup holders or storage compartments for added convenience.

Adapt: Adapt the adjustable armrests to include a swivel function for greater flexibility and ease of movement.

Modify: Modify the adjustable armrests to include temperature-regulating materials for added comfort during prolonged use.

Put to another use: Use the adjustable armrest mechanism to adjust other parts of the chair, such as the seat depth or lumbar support.

Eliminate: Eliminate the adjustable armrest controls and instead offer preset height and angle options to simplify the design.

Reverse: Reverse the direction of adjustment for the armrests, allowing users to adjust them from the front of the chair.

SCAMPER

Concept 4: Include a built-in footrest that extends when the backrest reclines for full-body support

Substitute: Substitute the built-in footrest with a retractable ottoman that slides out from under the chair for added versatility.

Combine: Combine the built-in footrest with a massage function for added relaxation and muscle relief.

Adapt: Adapt the built-in footrest to include adjustable height settings for personalized leg support.

Modify: Modify the built-in footrest to include heating elements for added comfort during use.

Put to another use: Use the built-in footrest as a standalone stool or ottoman for use outside of the chair.

Eliminate: Eliminate the built-in footrest and instead offer a separate ottoman accessory for users who desire leg support.

Reverse: Reverse the direction of extension for the built-in footrest, allowing users to extend it manually when needed.

SCAMPER

Concept 5: Create a comfort seat with foam density calibrated to the ILD Standard, offering consistent support and cushioning tailored to individual preferences for prolonged comfort during seating

Substitute: Substitute the foam seat cushion with a memory foam cushion for enhanced pressure relief and comfort.

Combine: Combine the comfort seat with a cooling gel layer for added temperature regulation and comfort during use.

Adapt: Adapt the comfort seat to include adjustable firmness settings for personalized support.

Modify: Modify the comfort seat to include perforations for improved airflow and breathability.

Put to another use: Use the comfort seat as a standalone cushion for use in other chairs or seats.

Eliminate: Eliminate the customizable firmness settings and instead offer preset firmness options to simplify the design.

Reverse: Reverse the direction of adjustment for the comfort seat, allowing users to adjust it from the front of the chair.

MODIFIED FINAL 5 CONCEPTS

Concept 1: Introduce an innovative headrest mechanism that seamlessly adapts to provide personalized neck support, accommodating users of varying heights and preferences with ease.

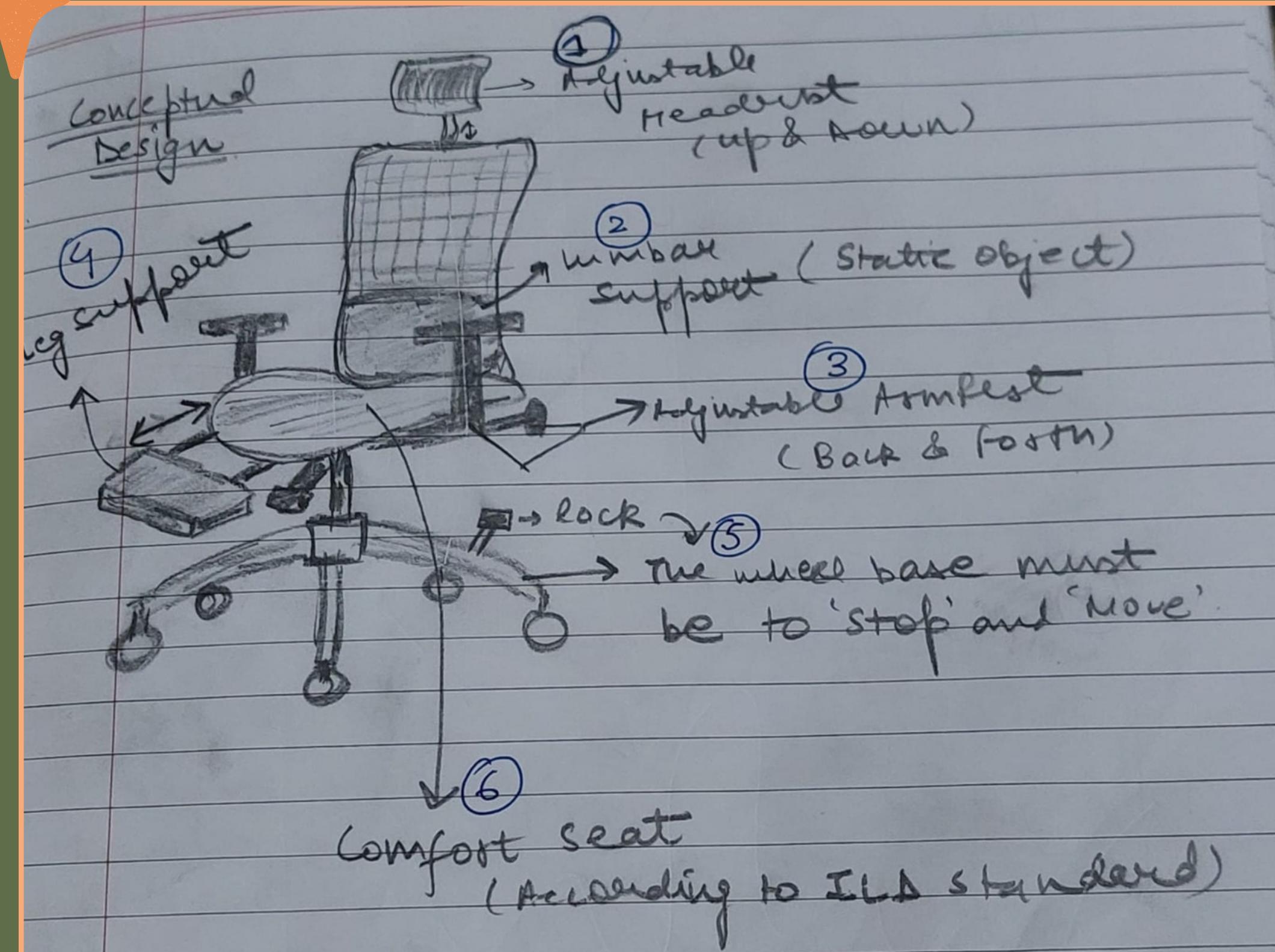
Concept 2: Engineer a dynamic lumbar support system that offers adjustable firmness levels, ensuring ideal spinal alignment and comfort for users of all body types.

Concept 3: Craft ergonomically designed armrests with user-friendly controls, enabling individuals to effortlessly customize the height and angle for optimal arm support during prolonged sitting sessions.

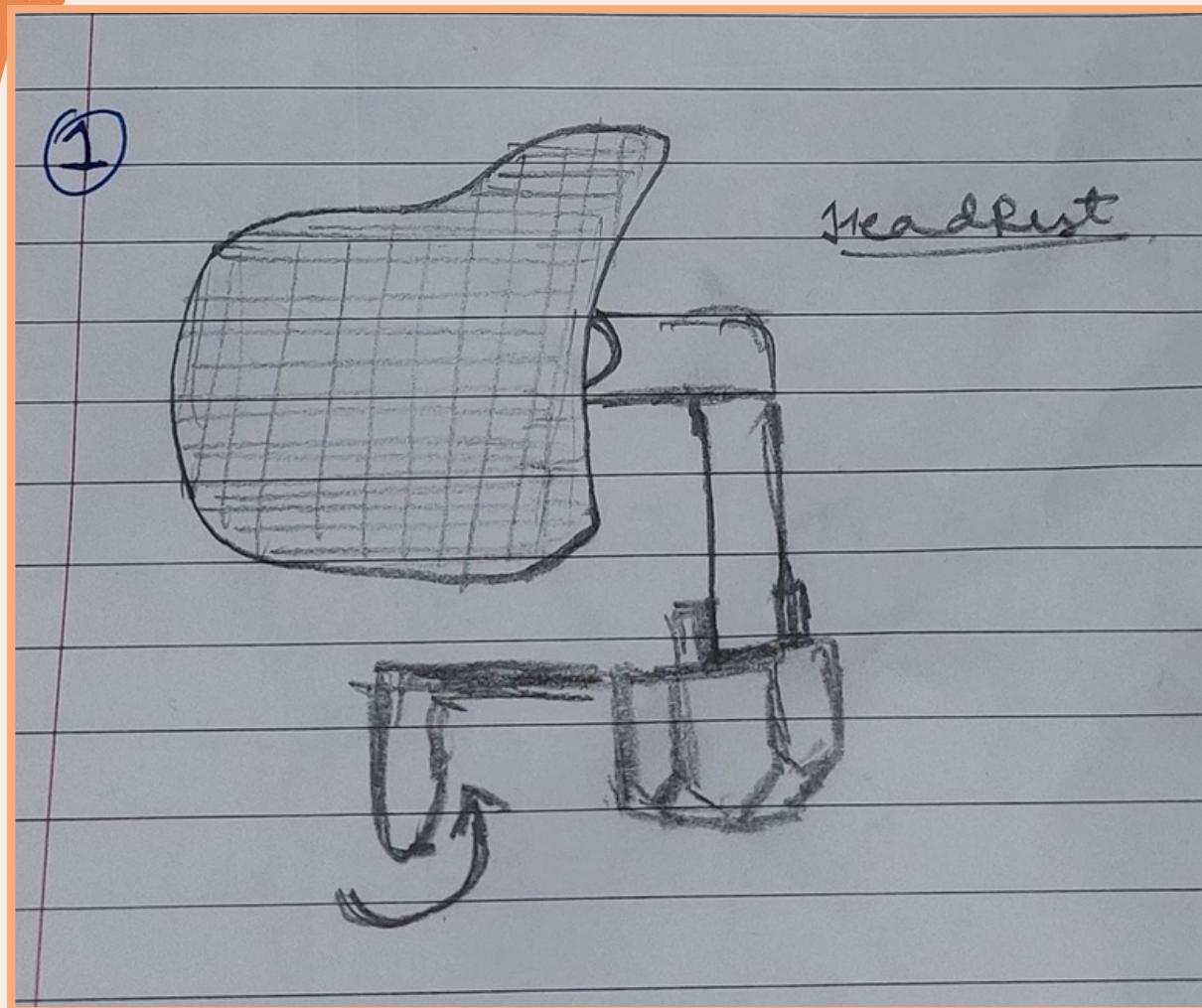
Concept 4: Incorporate a convenient footrest feature that automatically extends when reclining the backrest, delivering comprehensive full-body support and relaxation.

Concept 5: Develop a luxurious seating experience with a comfort seat engineered to the ILD Standard, providing consistent cushioning and support tailored to individual preferences for enduring comfort during extended periods of use.

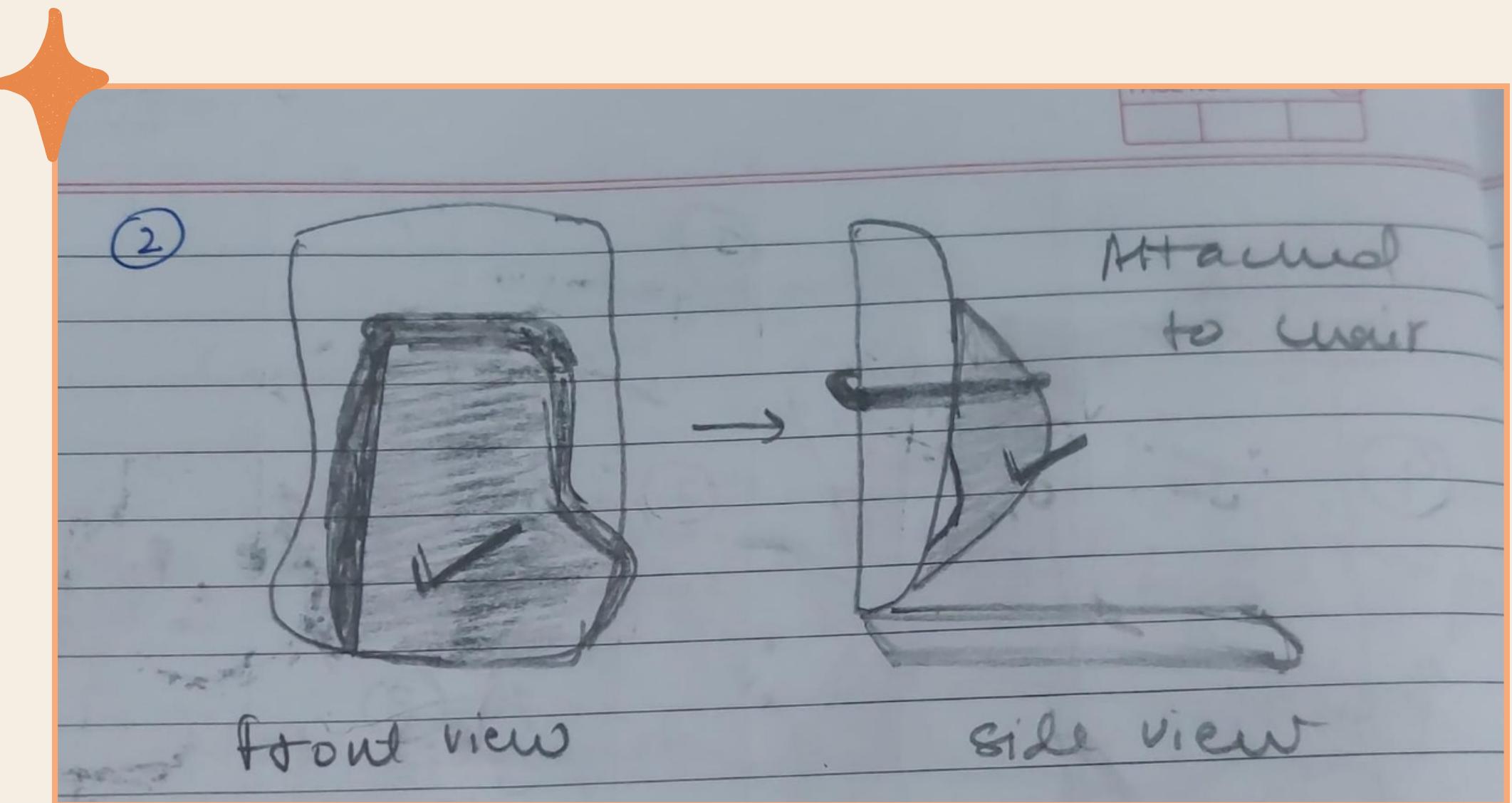
ANNOTATED SKETCHES OF FINAL CONCEPTS



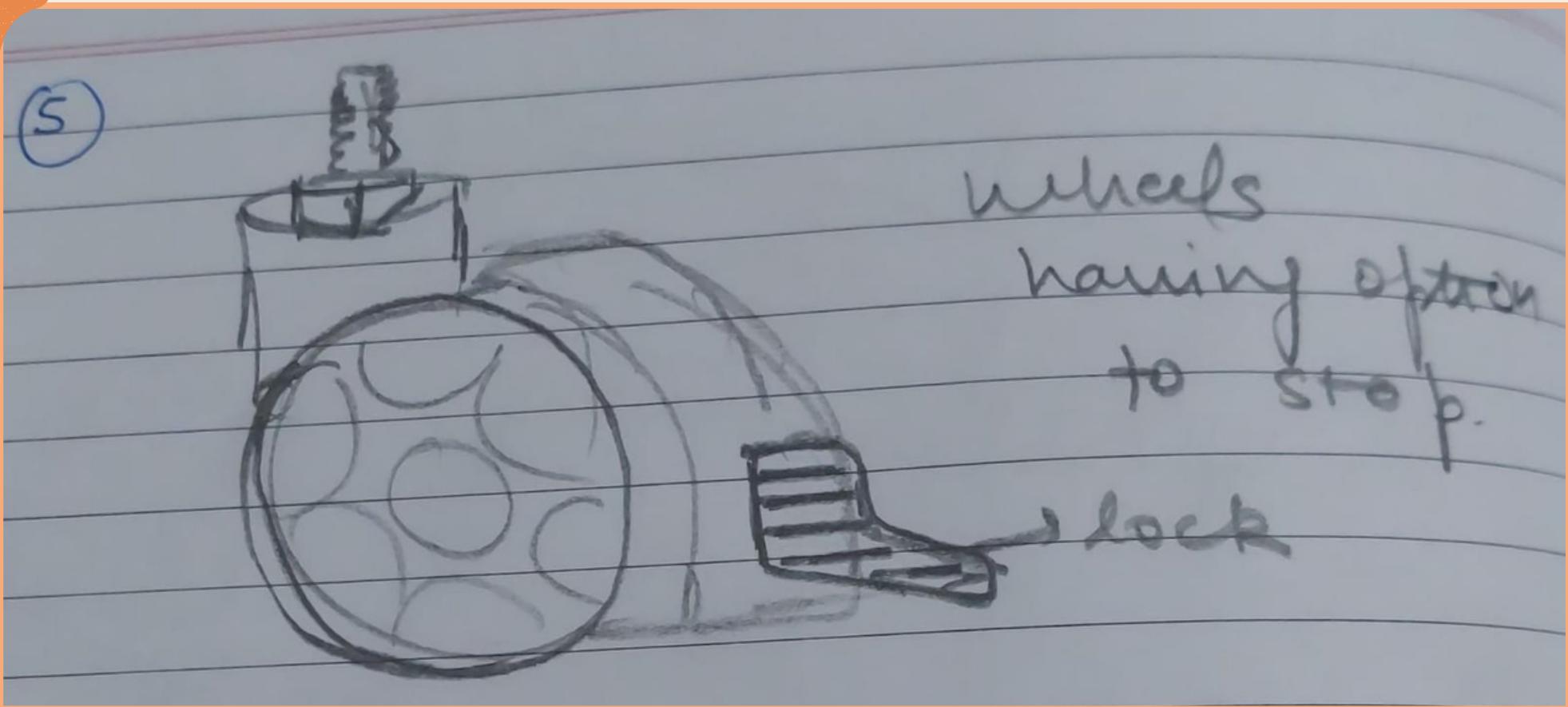
Overall Diagram of ergonomically designed chair



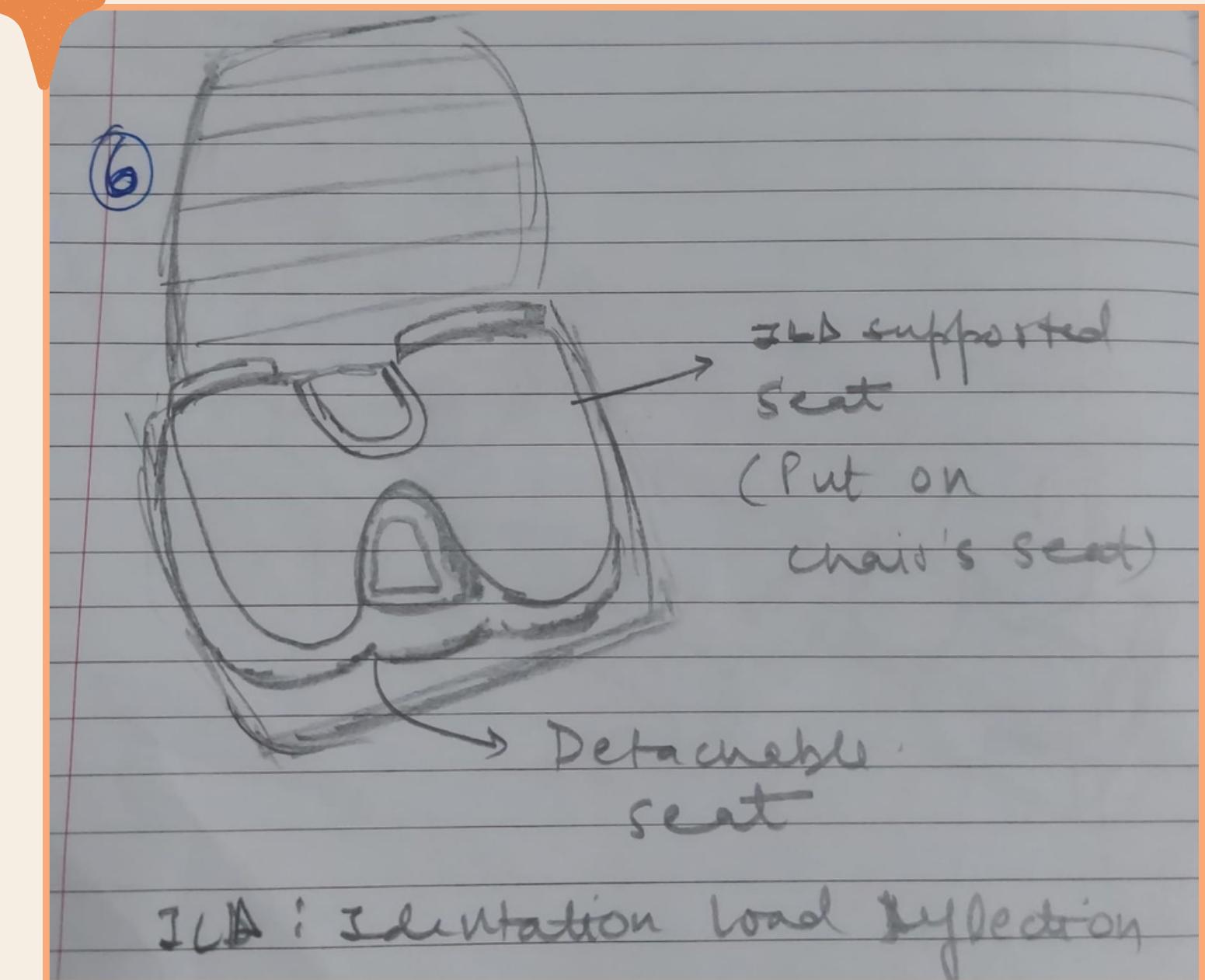
Headrest ,can move up and down



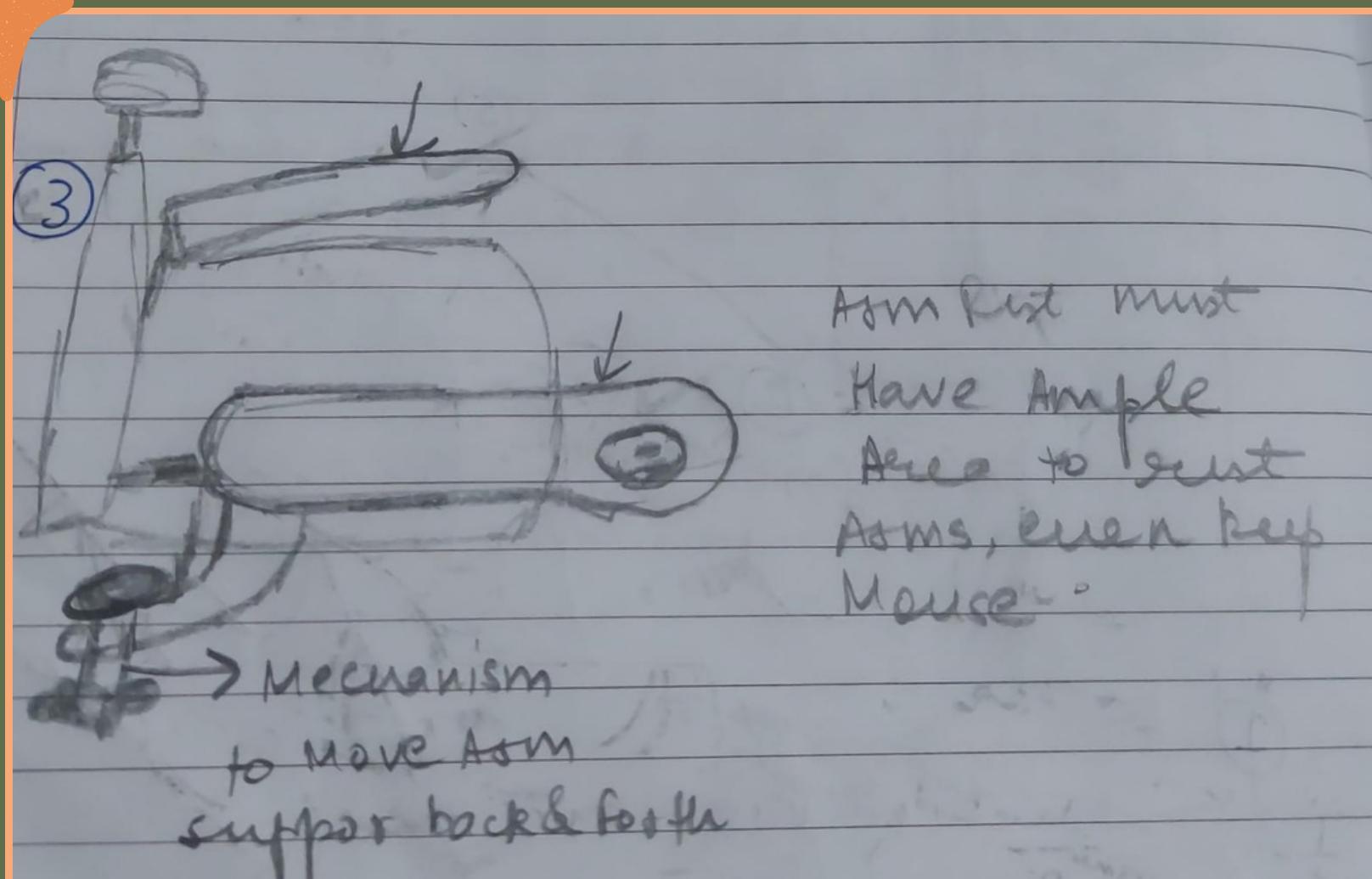
**Lumbar support attached to the chair
(detachable),can be aligned to user's
comfort**



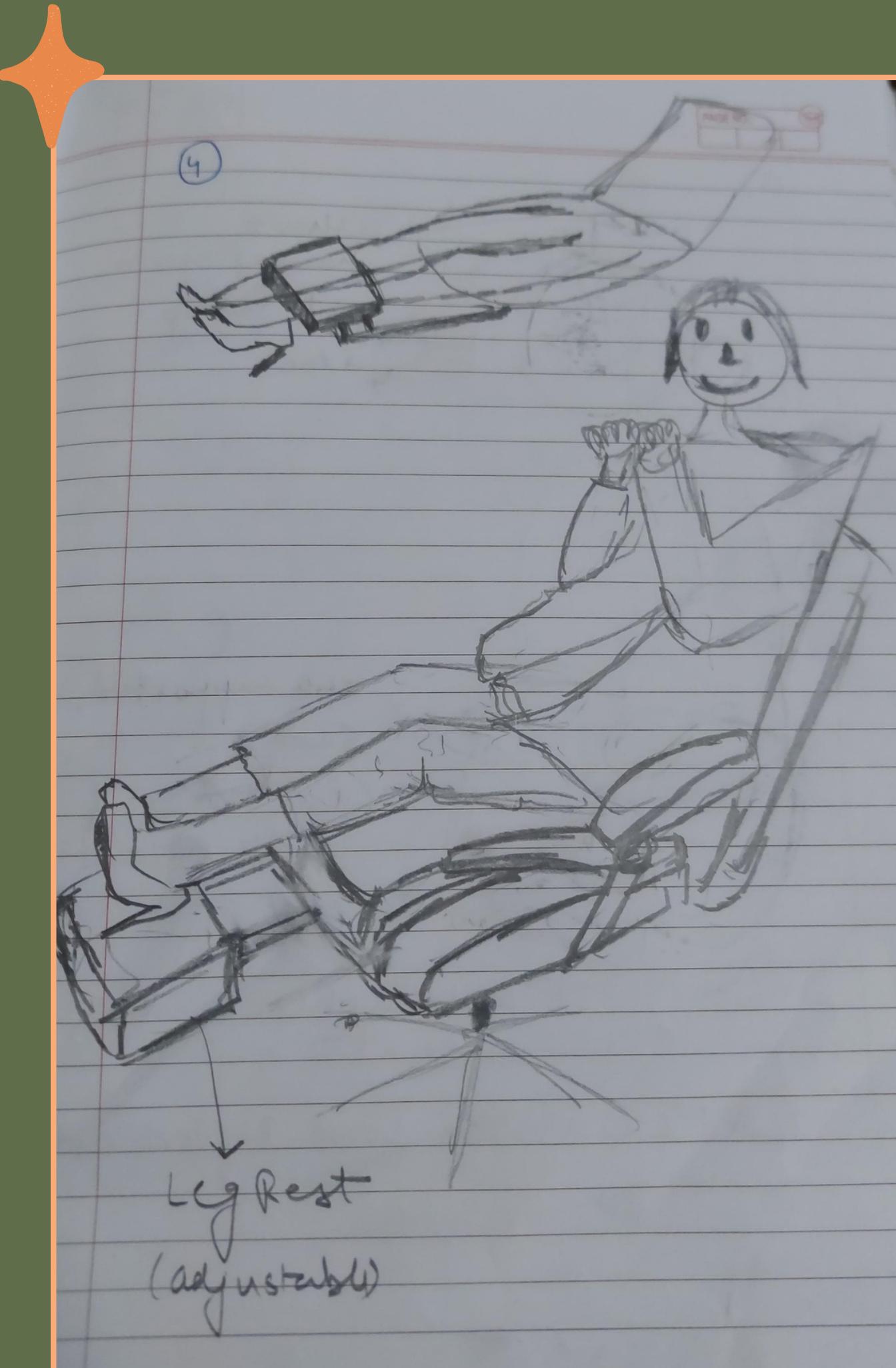
Wheel of chair that can stop (by lock) as per user's need when they don't want the chair to move around.



Detachable seat cushion to enhance user comfort



Armrest having sufficient width ,having mechanism to move sideways.



Chair having option of Leg rest

*Thank
you!*