Material Ideation Toolkit:

Flashcard-based Experiential Learning in Product Design

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INSPIRING FUTURES

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Material Ideation Toolkit:

Flashcard-based Experiential Learning in Product Design

Material Ideation is a design approach that **leverages unconventional and traditional materials** to **inspire new ideas and solutions**.

By exploring the properties, limitations, and possibilities of different materials, designers can develop innovative products that **challenge expectations** and **expand creative boundaries**.

Design A Chair...

Oak Chair

Expanded Polystyrene Cup

Max Lamb - Poly Chair

The Ideation Process:

At the core of design education is **problem-based learning**. This is due to the discipline's nature, which uses creative skills and processes to define and solve problems.

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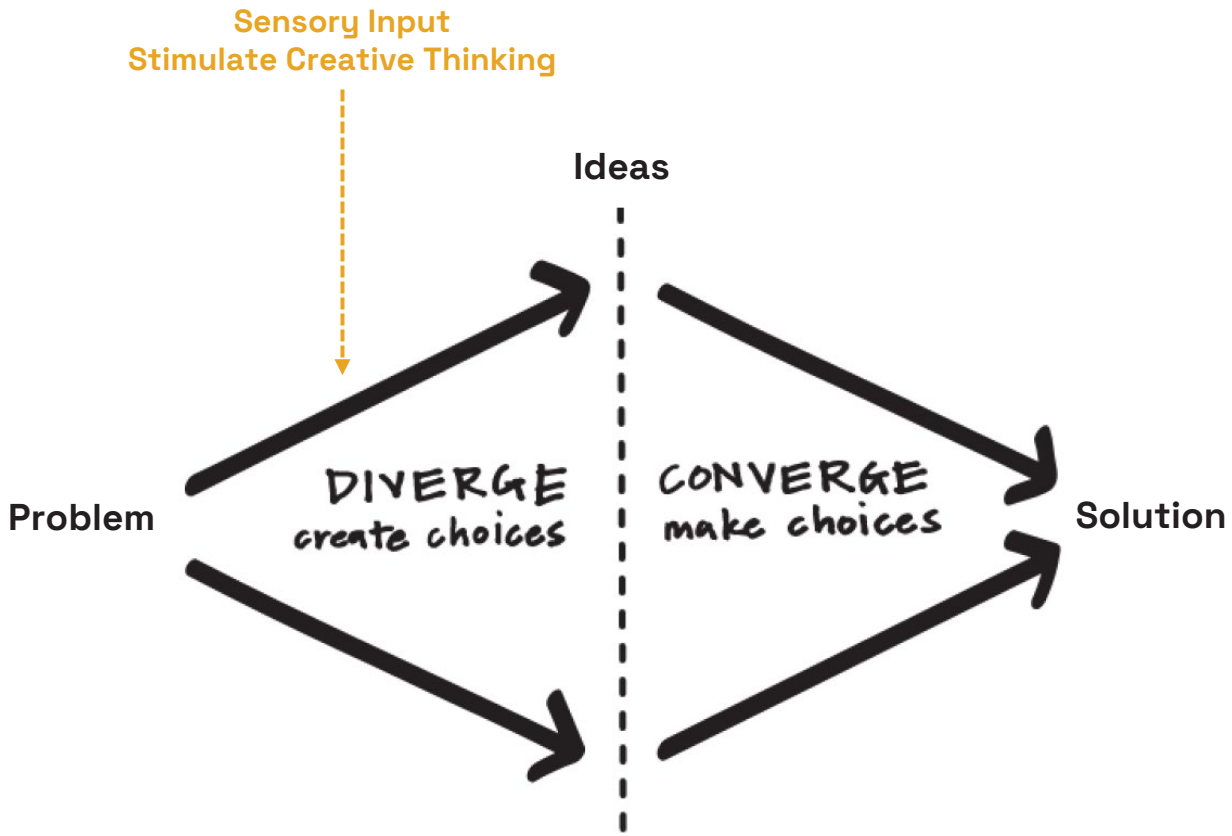
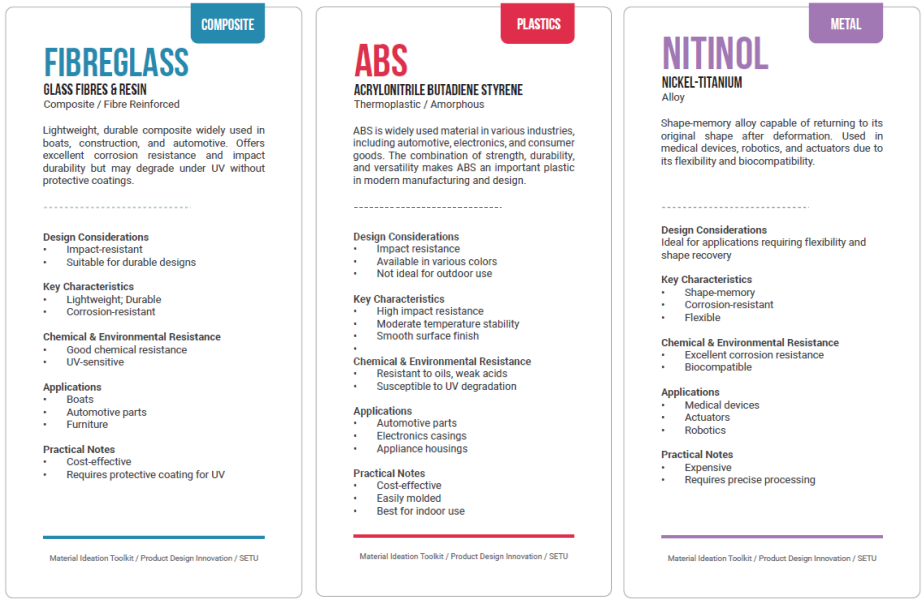
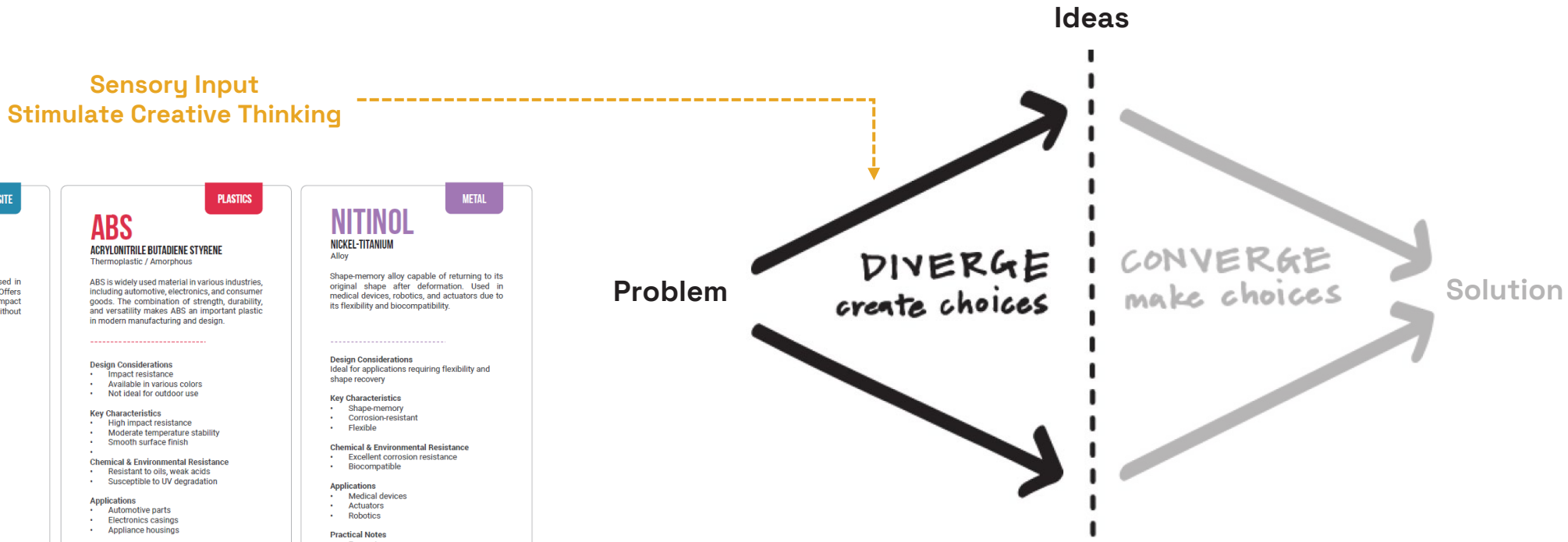
Material Ideation is a design approach that leverages unconventional and traditional materials to inspire new ideas and solutions – Stimulate Creative Thinking.



The Ideation Process:

Students can use flashcards to **'Stimulate Creative Thinking'** about materials in product design and support the development of **material-driven ideas and solutions.**





The Flashcard Design:

Sensory Input
(Flashcards)

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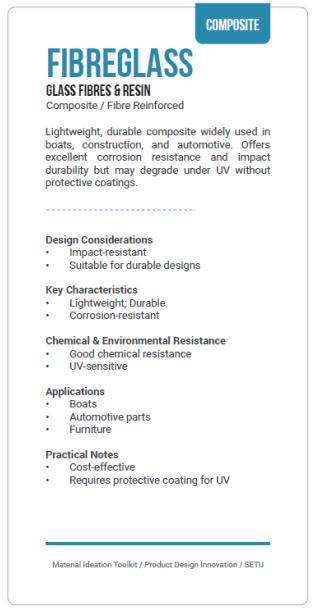
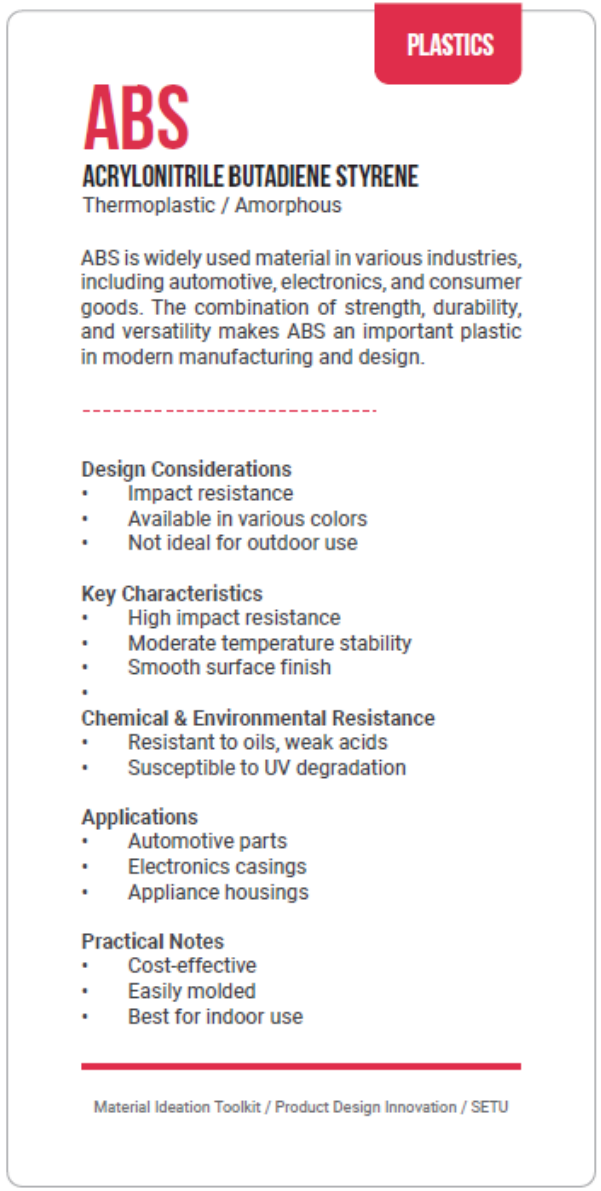
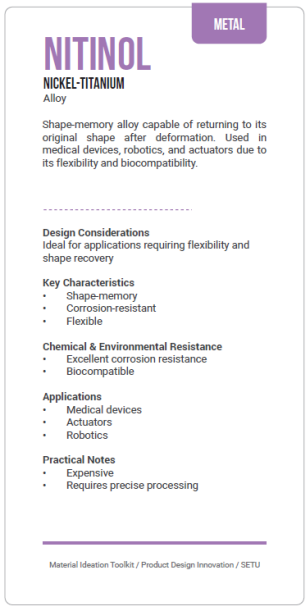
Facilitates Discussion
Encourages Reflection
Informs Knowledge Development
Supports Ideation Process

Creates An Experience For Students



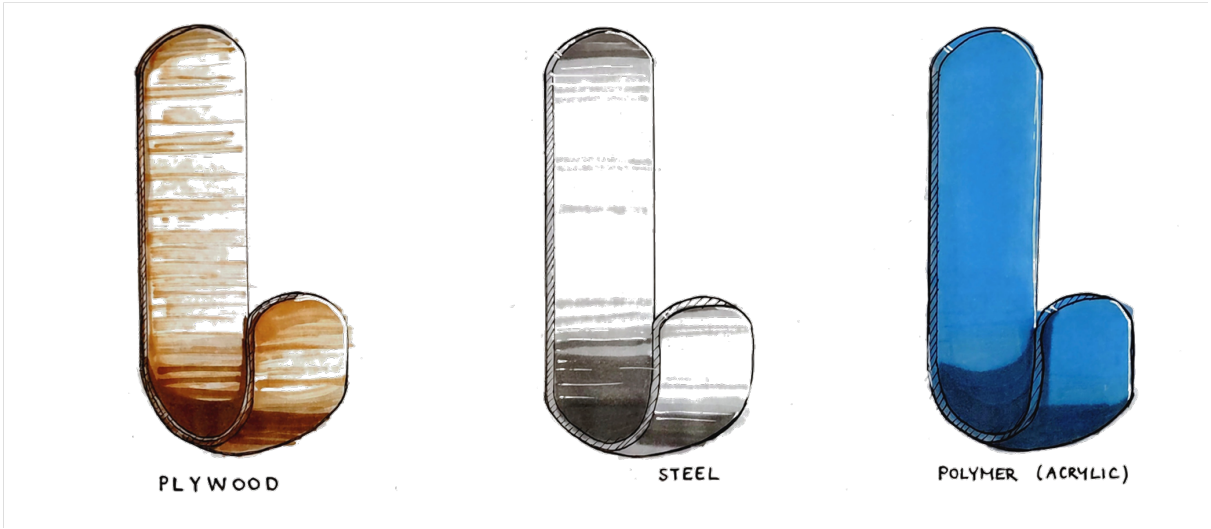


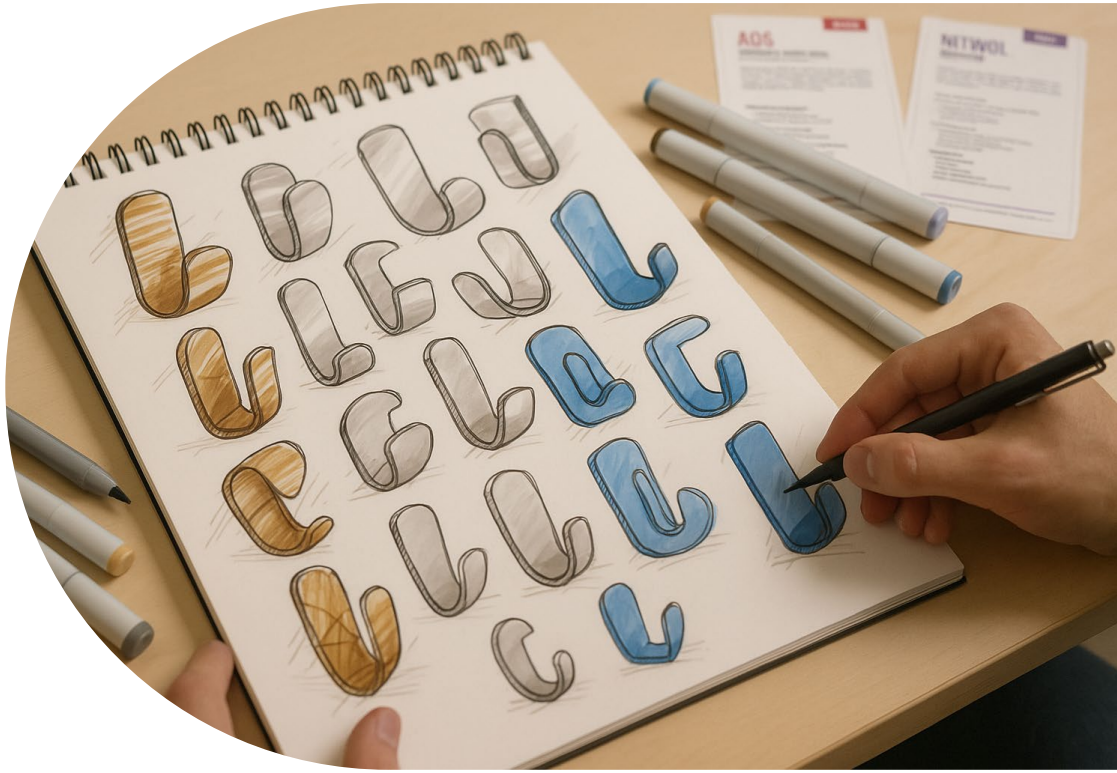


The Studio Impact:

Problem-Based Learning
(Design Projects)

First Year Studio Project / Coat Hook Design





The Studio Impact:

Problem-Based Learning (Design Projects)
+
Sensory Input (Flashcards)

By experimenting with materials, designers push the boundaries of what's possible, often leading to innovative forms and concepts that resonate on both functional and emotional levels.

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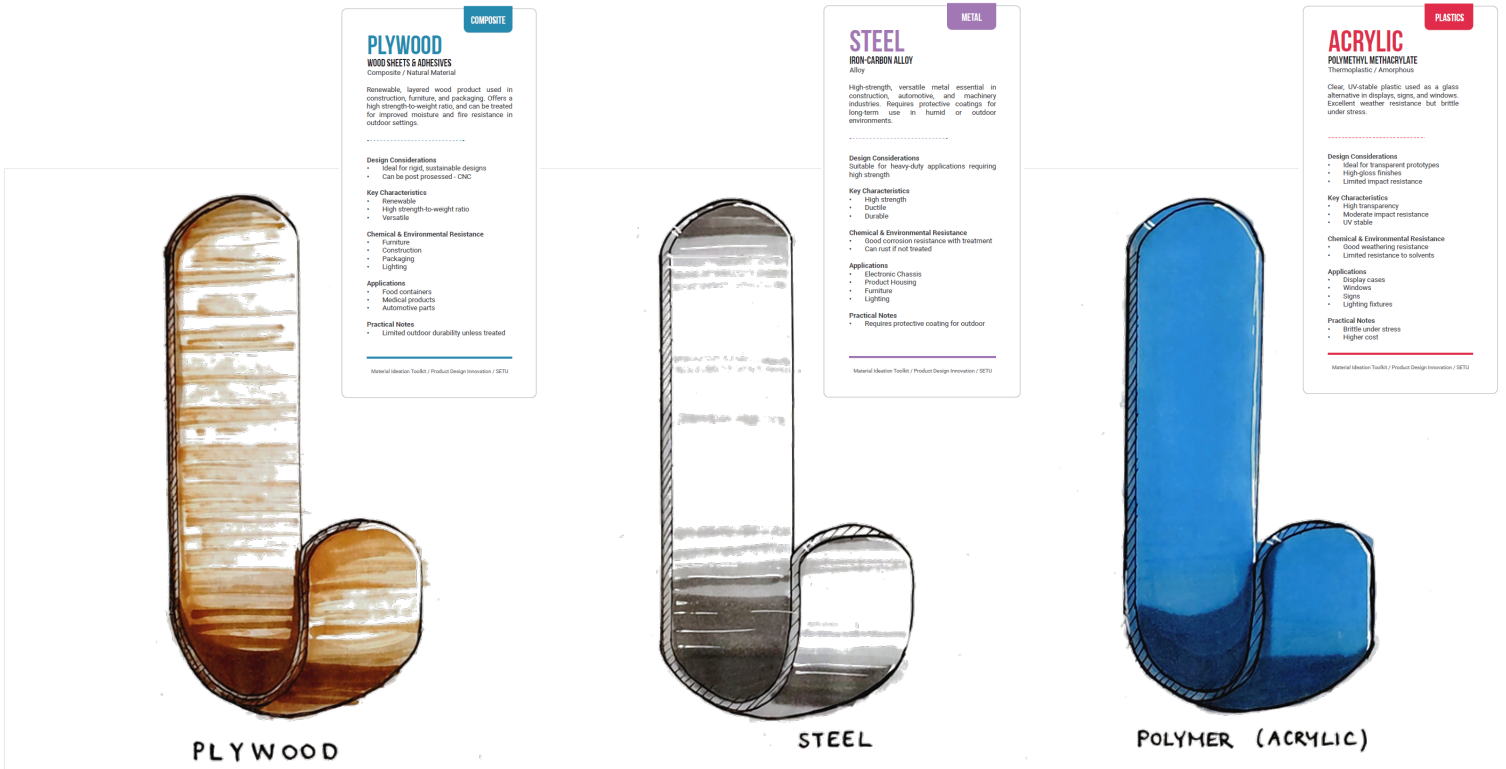
Student Discussions:

- **Acrylic** / Will it break? Does it need to be thicker? (Form)
- **Steel** / Will it rust? (Environmental)
- **Plywood** / How do we form this? (Manufacturing)

The students' design is pushed forward and developed through dialogue and reflection based on materials.



The Theory:

Constructivist Pedagogy

Emphasises that learners actively construct their understanding and knowledge through experience, reflection, and interaction.

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Facilitates knowledge growth using problem-based learning and **response to sensory inputs** (Brown and King, 2000).

Bruner (1990) defined this constructivist framework for teaching and learning as **'meaning making'.**

- Linking of modules, learning and application skills.
- Students must make meaning of knowledge and apply it to the studio projects (coat hook).

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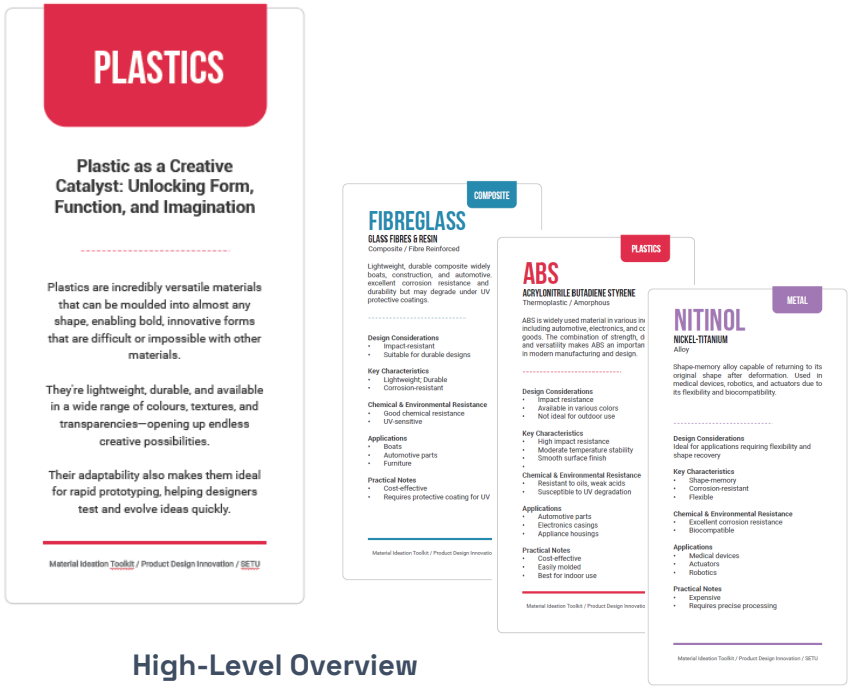
Materials as a solution pathway require a **foundational understanding of materials and their characteristics** (Parisi et al., 2017). This is grounded by **didactic pedagogy** in the materials module and linked to Studio Projects through flashcards.

The Next Steps:

- Positive feedback from students – Having a physical tool to hand provides a sense of structure and inspiration within the ideation process.
- Develop High-level Material Cards & Manufacturing Process Cards.
- Integrate Technology (Material Scanner)



High-Level Overview
Flash Cards Development

Manufacturing Process
Flash Cards Development

PSMK2 Plastic Scanner
SATLE24 Application (T&L)

PLASTICS

ABS
ACRYLONITRILE BUTADIENE STYRENE
Thermoplastic / Amorphous

ABS is widely used material in various industries, including automotive, electronics, and consumer goods. The combination of strength, durability, and versatility makes ABS an important plastic in modern manufacturing and design.

Design Considerations
- Impact resistance
- Available in various colors
- Not ideal for outdoor use

Key Characteristics
- High impact resistance
- Moderate temperature stability
- Smooth surface finish

Chemical & Environmental Resistance
- Resistant to oils, weak acids
- Susceptible to UV degradation

Applications
- Automotive parts
- Electronics casings
- Appliance housings

Practical Notes
- Cost-effective
- Easily molded
- Best for indoor use

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PLASTICS

PP
POLYPROPYLENE
Thermoplastic / Semi-Crystalline

Versatile and cost-effective plastic used in food containers, medical products, and textiles. It is lightweight, flexible, and durable, though it can become brittle at very low temperatures and requires UV protection.

Design Considerations
- Useful for items with moving parts
- Limited paintability
- Often used for food-safe designs
- Moldable into living hinges

Key Characteristics
- High fatigue resistance
- Lightweight
- Versatile and flexible

Chemical & Environmental Resistance
- Resistant to acids, bases, solvents
- Susceptible to UV exposure

Applications
- Food containers
- Medical products
- Automotive parts

Practical Notes
- Brittle in very cold temperatures
- Good for reusable items

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PLASTICS

PC
POLYCARBONATE
Thermoplastic / Amorphous

Transparent, impact-resistant plastic commonly used for safety glasses, electronics, and automotive lenses. Good heat resistance, but needs UV protection for outdoor use to prevent degradation.

Design Considerations
- Ideal for transparent applications
- Easily scratchable
- Durable and impact-resistant items

Key Characteristics
- High impact resistance
- Transparent
- Good heat resistance

Chemical & Environmental Resistance
- Moderate chemical resistance
- UV-sensitive without coating

Applications
- Safety glasses
- Electronics
- Automotive lenses

Practical Notes
- Higher cost than some plastics
- Needs UV coating for outdoor use

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PLASTICS

PE
POLYETHYLENE
Thermoplastic / Semi-Crystalline

Lightweight and flexible with excellent chemical resistance, polyethylene is widely used in packaging, containers, and piping. It's cost-effective but lacks rigidity at higher temperatures.

Design Considerations
- Limited finishing options
- Suitable for single-use products

Key Characteristics
- Flexible, lightweight
- Good impact resistance
- Low density

Chemical & Environmental Resistance
- Excellent resistance to most acids, bases, and solvents

Applications
- Packaging
- Containers
- Piping
- Bags

Practical Notes
- Low melting point
- Limited rigidity in high temperatures

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PLASTICS

PVC
POLYVINYL CHLORIDE
Thermoplastic / Amorphous

Rigid, durable plastic available in both rigid and flexible forms. Commonly used in pipes, flooring, and medical tubing, but releases harmful gases if burned, limiting its suitability in high-temperature applications.

Design Considerations
- Cost-effective
- Variety of finishes
- Environmental considerations

Key Characteristics
- Durable and rigid
- Good insulation properties
- Versatile

Chemical & Environmental Resistance
- Good resistance to oils, acids
- Susceptible to pollutants

Applications
- Pipes
- Electrical insulation
- Flooring
- Medical tubing

Practical Notes
- Can release harmful gases when burned

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PLASTICS

ACRYLIC
POLYMETHYL METHACRYLATE
Thermoplastic / Amorphous

Clear, UV-stable plastic used as a glass alternative in displays, signs, and windows. Excellent weather resistance but brittle under stress.

Design Considerations
- Ideal for transparent prototypes
- High-gloss finishes
- Limited impact resistance

Key Characteristics
- High transparency
- Moderate impact resistance
- UV stable

Chemical & Environmental Resistance
- Good weathering resistance
- Limited resistance to solvents

Applications
- Display cases
- Windows
- Signs
- Lighting fixtures

Practical Notes
- Brittle under stress
- Higher cost

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PLASTICS

HDPE
HIGH-DENSITY POLYETHYLENE
Thermoplastic / Semi-Crystalline

Strong, lightweight plastic known for its water and impact resistance. Commonly used in outdoor furniture, containers, and piping, with UV-stabilized versions available for added durability in outdoor settings.

Design Considerations
- Ideal for lightweight, durable designs
- Limited for high-heat applications

Key Characteristics
- Lightweight
- Impact resistant
- Durable

Chemical & Environmental Resistance
- Excellent chemical and moisture resistance

Applications
- Outdoor furniture
- Containers
- Piping

Practical Notes
- UV-stabilized versions available for outdoor use

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PLASTICS

PTFE
POLYTETRAFLUOROETHYLENE
Thermoplastic / Semi-Crystalline

Non-stick, low-friction plastic with high heat resistance. Used in seals, bearings, and cookware due to its chemical stability, PTFE can be challenging to bond and requires specialised handling.

Design Considerations
- Suitable for low-friction applications
- High-temp applications

Key Characteristics
- Very low friction
- High heat
- chemical resistance

Chemical & Environmental Resistance
- Inert to most chemicals
- Heat resistant up to 260°C

Applications
- Non-stick cookware
- Seals
- Bearings

Practical Notes
- Requires special handling for bonding

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PLASTICS

LSR
LIQUID SILICONE RUBBER / SILICONE
Thermoset / Elastomer

Heat-resistant, flexible elastomer often used in seals and kitchenware. LSR is durable, water-resistant, and biocompatible, making it ideal for medical and food-contact applications, with various color options.

Design Considerations
- Flexible
- Heat resistant
- Water resistant

Key Characteristics
- Suitable for soft-touch
- High-temp applications

Chemical & Environmental Resistance
- Highly resistant to H2O
- Highly resistant to many chemicals

Applications
- Seals
- Kitchenware
- Medical implants

Practical Notes
- Available in multiple colors
- Requires curing

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PLASTICS

NYLON
POLYAMIDE
Thermoplastic / Semi-Crystalline

Strong, wear-resistant plastic with moderate flexibility, commonly used in gears, bearings, and textiles. It absorbs moisture, which can affect its properties over time, so it's best in dry environments.

Design Considerations
- Great for durable load-bearing applications

Key Characteristics
- High tensile strength
- Good wear resistance
- Moderate flexibility

Chemical & Environmental Resistance
- Sensitive to moisture
- Limited resistance to acids and bases

Applications
- Gears
- Bearings
- Textiles

Practical Notes
- Absorbs moisture
- Needs drying before molding

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PLASTICS

PU
POLYURETHAN
Thermoset / Elastomer

Versatile and durable, PU is used in cushioning, coatings, and wheels. It is highly abrasion-resistant and available in both rigid and flexible forms, but is UV-sensitive without stabilizers.

Design Considerations
- Ideal for cushioning and abrasion-resistant applications

Key Characteristics
- Flexible; Abrasion-resistant
- Can be rigid or flexible

Chemical & Environmental Resistance
- Resistant to oils and solvents
- UV-sensitive

Applications
- Foam cushions
- Wheels
- Coatings
- Seals

Practical Notes
- High durability in specific environments

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PLASTICS

POM
POLYOXYMETHYLENE
Thermoplastic / Semi-Crystalline

Stiff, low-friction plastic ideal for precision parts like gears and bearings. POM provides good dimensional stability and wear resistance, though it's UV-sensitive and costly for high-precision applications.

Design Considerations
- Ideal for precision, low-friction parts

Key Characteristics
- High stiffness
- Low friction
- Good wear resistance

Chemical & Environmental Resistance
- Resistant to most chemicals
- Sensitive to UV

Applications
- Gears
- Bearings
- Automotive components

Practical Notes
- Higher cost for precision applications

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METAL

ALUMINIUM
AL-13
Element

Lightweight, corrosion-resistant metal used in aerospace, electronics, and construction. Easily machined and offers good thermal conductivity with recyclable alloys for sustainability.

Design Considerations
Ideal for lightweight, structural applications

Key Characteristics
- Lightweight
- High strength-to-weight ratio
- Corrosion resistant

Chemical & Environmental Resistance
- Good corrosion resistance
- Susceptible to acidic environments

Applications
- Electronic Chassis
- Product Housing
- Furniture
- Lighting

Practical Notes
- Recyclable
- Various alloys available

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METAL

STEEL
IRON-CARBON ALLOY
Alloy

High-strength, versatile metal essential in construction, automotive, and machinery industries. Requires protective coatings for long-term use in humid or outdoor environments.

Design Considerations
Suitable for heavy-duty applications requiring high strength

Key Characteristics
- High strength
- Ductile
- Durable

Chemical & Environmental Resistance
- Good corrosion resistance with treatment
- Can rust if not treated

Applications
- Electronic Chassis
- Product Housing
- Furniture
- Lighting

Practical Notes
- Requires protective coating for outdoor

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METAL

COPPER
CU- 29
Element

Highly conductive, corrosion-resistant metal commonly used in electrical wiring, plumbing, and heat exchangers. Its antimicrobial properties make it valuable for hygiene-critical applications.

Design Considerations
Ideal for conductive and antimicrobial applications

Key Characteristics
- High electrical and thermal conductivity
- Antimicrobial

Chemical & Environmental Resistance
- Excellent corrosion resistance
- Reacts with acids

Applications
- Electrical wiring
- Plumbing
- Heat exchangers

Practical Notes
- Expensive
- Malleable
- Recyclable

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METAL

IRON
FE-26
Element

Strong and inexpensive metal used widely in construction and manufacturing. Prone to rust, it requires protective coatings for outdoor or high-humidity environments.

Design Considerations
Ideal for structural and heavy-duty applications

Key Characteristics
- Strong
- Magnetic
- Malleable

Chemical & Environmental Resistance
- Prone to rust
- Requires protective coatings

Applications
- Structural components
- Tools
- Machinery

Practical Notes
- Requires regular maintenance to prevent corrosion

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METAL

TITANIUM
TI-22
Element

Strong, lightweight, and biocompatible metal used in aerospace, medical implants, and sporting goods. Offers excellent corrosion resistance but can be challenging and costly to machine.

Design Considerations
Ideal for high-performance and weight-sensitive applications

Key Characteristics
- Lightweight
- High strength
- Biocompatible

Chemical & Environmental Resistance
- Excellent corrosion resistance
- High temperature resistance

Applications
- Aerospace
- Medical implants
- Sports equipment

Practical Notes
- Expensive
- Difficult to machine

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METAL

NICKEL
NI-28
Element

Hard, corrosion-resistant metal used in batteries, plating, and high-strength alloys. It is valued for its durability in high-temperature and chemically aggressive environments.

Design Considerations
Suitable for high-temperature and corrosion resistant applications

Key Characteristics
- Corrosion-resistant
- Hard
- Magnetic

Chemical & Environmental Resistance
- Excellent corrosion resistance
- Resistant to chemicals and heat

Applications
- General Plating
- Chemical processing equipment

Practical Notes
- Often alloyed with other metals

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METAL

ZINC
ZN
Element

Corrosion-resistant metal commonly used in galvanising and die-casting. It is cost-effective for small mechanical parts but lacks the strength required for heavy-duty applications.

Design Considerations
Suitable for low-cost, corrosion-resistant castings

Key Characteristics
- Corrosion-resistant
- Low melting point

Chemical & Environmental Resistance
- Good corrosion resistance
- Limited strength

Applications
- Galvanising
- Die-casting
- Small mechanical parts

Practical Notes
- Easily cast
- Not ideal for structural applications

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METAL

BRASS
COPPER-ZINC
Alloy

Strong, corrosion-resistant alloy with an attractive appearance, commonly used in decorative fittings, valves, and musical instruments. Offers good machinability and durability.

Design Considerations
Suitable for decorative and corrosion-resistant applications

Key Characteristics
- Corrosion-resistant
- Attractive appearance

Chemical & Environmental Resistance
- Good corrosion resistance
- Tarnishes over time

Applications
- Fittings
- Musical instruments
- Jewellery

Practical Notes
- Malleable
- Recyclable
- Requires polishing

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METAL

NITINOL
NICKEL-TITANIUM
Alloy

Shape-memory alloy capable of returning to its original shape after deformation. Used in medical devices, robotics, and actuators due to its flexibility and biocompatibility.

Design Considerations
Ideal for applications requiring flexibility and shape recovery

Key Characteristics
- Shape-memory
- Corrosion-resistant
- Flexible

Chemical & Environmental Resistance
- Excellent corrosion resistance
- Biocompatible

Applications
- Medical devices
- Actuators
- Robotics

Practical Notes
- Expensive
- Requires precise processing

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COMPOSITE

CARBON FIBER
CARBON FIBRES & RESIN
Composite / Fibre Reinforced

Strong, lightweight composite used in aerospace, automotive, and sports. Offers excellent tensile strength and low weight for high-performance applications, though costly and labour-intensive to manufacture

Design Considerations
- Lightweight, high-strength applications
- Not suitable for complex shapes

Key Characteristics
- Extremely strong
- Lightweight; Rigid

Chemical & Environmental Resistance
- Excellent chemical resistance
- UV-sensitive unless coated

Applications
- Aerospace
- Automotive
- Sports equipment

Practical Notes
- Expensive
- Requires specialised handling

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COMPOSITE

PLYWOOD
WOOD SHEETS & ADHESIVES
Composite / Natural Material

Renewable, layered wood product used in construction, furniture, and packaging. Offers a high strength-to-weight ratio, and can be treated for improved moisture and fire resistance in outdoor settings.

Design Considerations
- Ideal for rigid, sustainable designs
- Can be post processed - CNC

Key Characteristics
- Renewable
- High strength-to-weight ratio
- Versatile

Chemical & Environmental Resistance
- Furniture
- Construction
- Packaging
- Lighting

Applications
- Food containers
- Medical products
- Automotive parts

Practical Notes
- Limited outdoor durability unless treated

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COMPOSITE

FIBREGLASS
GLASS FIBRES & RESIN
Composite / Fibre Reinforced

Lightweight, durable composite widely used in boats, construction, and automotive. Offers excellent corrosion resistance and impact durability but may degrade under UV without protective coatings.

Design Considerations
- Impact-resistant
- Suitable for durable designs

Key Characteristics
- Lightweight; Durable
- Corrosion-resistant

Chemical & Environmental Resistance
- Good chemical resistance
- UV-sensitive

Applications
- Boats
- Automotive parts
- Furniture

Practical Notes
- Cost-effective
- Requires protective coating for UV

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COMPOSITE

GLASS-FILLED PP
POLYPROPYLENE & GLASS FIBRES
Composite / Fibre Reinforced

Reinforced polypropylene with added strength for automotive and electrical parts. Combines the lightweight flexibility of polypropylene with enhanced tensile and thermal properties from glass fibres.

Design Considerations
- Suitable for reinforced plastic designs requiring strength and lightweight characteristics

Key Characteristics
- Impact-resistant
- Lightweight
- Rigid

Chemical & Environmental Resistance
- Good chemical resistance
- UV-sensitive

Applications
- Automotive parts
- Electrical housings
- Medical devices

Practical Notes
- Stronger than standard polypropylene

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Stimulate Creative Thinking

Sensory Input > Problem-Based Learning

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Note of Thanks:

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