

Supported Focus Companion

International Baccalaureate · IB Diploma · Design Tech- nology · HL

Source-supported focus teaching; remaining qualification requirements are held

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Original teaching and practice · exercises.lol

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Design in theory · supported focus

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Scope and prerequisites

Supported HL focus. First assessment 2027 target; current brief and public guide return 403; 2016 SL/HL briefs are historical. Remaining guide, assessment and practical requirements retain their recorded holds.

Prerequisites: read the stated quantities and units, use arithmetic and the model conditions below. Each lesson develops its own method before independent transfer.

These are original or explicitly fictional teaching examples, not actual measurements or completed assessed learner investigations.

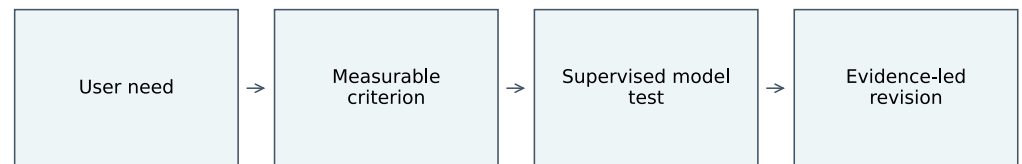
Designing for actual users

■ What would explain this observation?

- A handle that feels comfortable to its designer may exclude another user. Design evidence starts with the people and context of use.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Anthropometric data describe body dimensions. **Ergonomics** concerns the relationship between people, tasks and products. A design **specification** turns a user need into a measurable requirement.
- ergonomics: Designing the fit between people, tasks and products; specification: Measurable requirements a proposed solution should meet.



■ Choose evidence that can test it

- Choose data for the target population and task. Clearance often needs a larger-user percentile; reach may need a smaller-user percentile. A single mean dimension cannot satisfy every design constraint.
- Observe an approved low-risk task with consent, interview users without leading questions, and record measurable success criteria. Test an early model before committing to expensive materials. Do not collect unnecessary personal measurements.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: a handle must withstand a 40 N use force with a design safety factor of 2.5. Target test load = use force $\times$ factor = $40 \times 2.5 = 100$ N. The factor is a design assumption to justify; it is not a substitute for a supervised safety review.

Example:

A use force is 30 N and selected safety factor 3. Find target load. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- A specification is not a list of vague wishes such as nice or strong. User testing should evaluate measurable requirements and reveal conflicting needs.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A population mean dimension always accommodates every user. This claim is false: A specification is not a list of vague wishes such as nice or strong. User testing should evaluate measurable requirements and reveal conflicting needs.

Key:

Designing for actual users: Choose data for the target population and task. Clearance often needs a larger-user percentile; reach may need a smaller-user percentile. A single mean dimension cannot satisfy every design constraint.

Ergonomics: fit a range of users

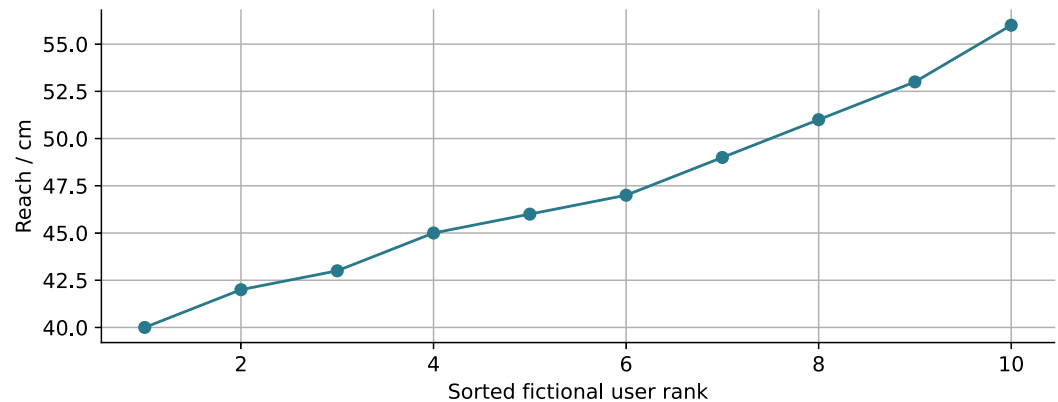
■ What would explain this observation?

- A handle sized for the average hand can exclude many intended users. Design decisions need a user range, task and context rather than one average.

- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- **Anthropometry** measures body dimensions; **ergonomics** considers interactions between people, tasks and products. A percentile locates a value within a specified distribution. Choosing a lower or upper percentile depends on whether the dimension concerns reach, clearance or another function. Adjustable design may accommodate a broader range than a single fixed dimension.
- anthropometry: Measurement of human body dimensions for a specified population and method; ergonomics: Study of interactions between people, tasks and systems to inform design.



■ Choose evidence that can test it

- A clearance dimension often needs to consider larger relevant body dimensions, while reach can require smaller relevant dimensions. Neither principle automatically selects a universal percentile. The measured population, posture, clothing, capability and task determine relevance. Consider physical, perceptual and cognitive demands together rather than assuming body size explains every usability issue.
- Define a consenting user group and task. Use attributed data or anonymous teacher-approved measurements, record measurement posture and units, and test safe low-fidelity models before construction. Include users whose access needs differ. Set measurable acceptance criteria and retain qualitative feedback about grip, visibility and comprehension alongside dimensions.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: sorted fictional reach measurements are 40, 42, 43, 45, 46, 47, 49, 51, 53 and 56 cm. Under a stated nearest-rank classroom convention, the 10th percentile uses $\text{rank} \lceil (0.10 \times 10) \rceil = 1$, giving 40 cm; the 90th uses rank 9, giving 53 cm. A 53 cm control distance is beyond the recorded reach of eight users. The small fictional sample does not define a product standard.

Example:

A stated nearest-rank method uses $\text{ceil}(p \times n)$. For $p=0.90$ and $n=20$, find the rank. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- Percentile methods differ, especially for small samples. A percentile is not a percentage of a body dimension. An average dimension and a successful test by one user do not establish accessible design.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A product dimension based on the mean automatically accommodates every intended user. This claim is false: Percentile methods differ, especially for small samples. A percentile is not a percentage of a body dimension. An average dimension and a successful test by one user do not establish accessible design.

Key:

Ergonomics: fit a range of users: A clearance dimension often needs to consider larger relevant body dimensions, while reach can require smaller relevant dimensions. Neither principle automatically selects a universal percentile. The measured population, posture, clothing, capability and task determine relevance. Consider physical, perceptual and cognitive demands together rather than assuming body size explains every usability issue.

Design in practice · supported focus

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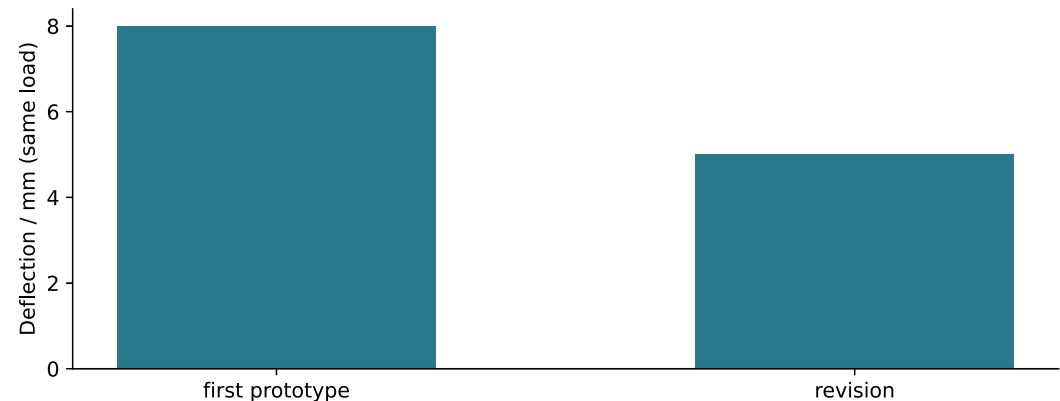
Models, materials and iterative prototyping

■ What would explain this observation?

- A cardboard **prototype** can reveal reach and arrangement without proving that the final material is strong enough. Different models answer different questions.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- A model represents selected features of a design. A prototype supports testing before or during development. Material selection depends on mechanical properties, manufacture, use conditions and end-of-life choices.
- prototype: A developing version used to test a solution; **iteration** : Revision guided by evidence and repeated testing.



■ Choose evidence that can test it

- State what each model includes and omits. Compare tests with the same load, geometry and conditions. Iteration means using evidence to revise a solution and testing the revision against the original success criteria.
 - Make a low-risk model under school workshop rules. Record dimensions, material, process and test method. Use photographs, measurements and user feedback as evidence. Machines and load tests require teacher supervision and approved guards.
-

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: a beam prototype deflects 8 mm under a stated load; a revision deflects 5 mm under the same conditions. $\text{Reduction} = (8-5)/8 \times 100 = 37.5\%$. The result supports greater stiffness in that test, not proof of every strength or fatigue property.

Example:

Deflection falls from 10 mm to 6 mm under equal conditions. Find percentage reduction. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ Check the conclusion and its limits

- Stiffness is resistance to elastic deformation; strength concerns failure stress. A visually accurate model need not reproduce material behaviour.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

An attractive model proves the final product mechanical safety. This claim is false: Stiffness is resistance to elastic deformation; strength concerns failure stress. A visually accurate model need not reproduce material behaviour.

Key:

Models, materials and iterative prototyping: State what each model includes and omits. Compare tests with the same load, geometry and conditions. Iteration means using evidence to revise a solution and testing the revision against the original success criteria.

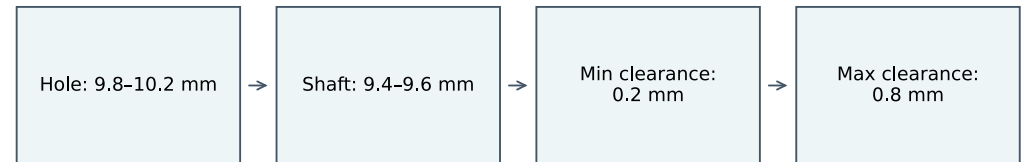
Manufacture: tolerances, variation and inspection

■ What would explain this observation?

- Two parts can each match a nominal drawing yet fail to assemble if allowed variation has not been considered. Manufacture produces a range of dimensions.
 - Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.
-

■ Build the model

- A **tolerance** specifies an allowed dimensional range around or beside a nominal value. Precision concerns consistency of repeated measurements or production, while accuracy concerns agreement with a reference. Process selection must consider material, geometry, quantity, surface finish, waste and achievable variation rather than appearance alone.
- tolerance: The allowed range of variation in a specified dimension; **clearance** : The dimensional space between mating parts under the stated model.



■ Choose evidence that can test it

- For a worst-case clearance model, subtract the largest shaft from the smallest hole for minimum clearance, and the smallest shaft from the largest hole for maximum clearance. The calculation assumes the stated dimensional limits and ideal geometry. Shape, alignment, temperature and measurement uncertainty can affect actual assembly.
- Use safe school-made models or a provided dimension dataset. Specify dimension units, nominal values and limits before testing. Measure with an appropriate calibrated instrument at agreed positions, record every result and classify against the specified range. Retain rejected pieces and explain whether the problem concerns the design limits, process variation or measurement method.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: a hole is 10.0 ± 0.2 mm, giving 9.8–10.2 mm; a shaft is 9.5 ± 0.1 mm, giving 9.4–9.6 mm. Minimum clearance is $9.8 - 9.6 = 0.2$ mm and maximum is $10.2 - 9.4 = 0.8$ mm. This model predicts positive clearance across the stated limits. It does not establish strength or fitness for a safety-critical application.

Example:

A hole ranges from 12.0 to 12.4 mm and a shaft from 11.5 to 11.8 mm. Calculate minimum clearance. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ Check the conclusion and its limits

- A tighter tolerance can increase cost, inspection time and waste, and may not improve the user outcome. A measuring instrument with a fine display does not automatically have the accuracy required to accept a part near its limit.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A finer instrument display guarantees sufficiently accurate dimensional inspection. This claim is false: A tighter tolerance can increase cost, inspection time and waste, and may not improve the user outcome. A measuring instrument with a fine display does not automatically have the accuracy required to accept a part near its limit.

Key:

Manufacture: tolerances, variation and inspection: For a worst-case clearance model, subtract the largest shaft from the smallest hole for minimum clearance, and the smallest shaft from the largest hole for maximum clearance. The calculation assumes the stated dimensional limits and ideal geometry. Shape, alignment, temperature and measurement uncertainty can affect actual assembly.

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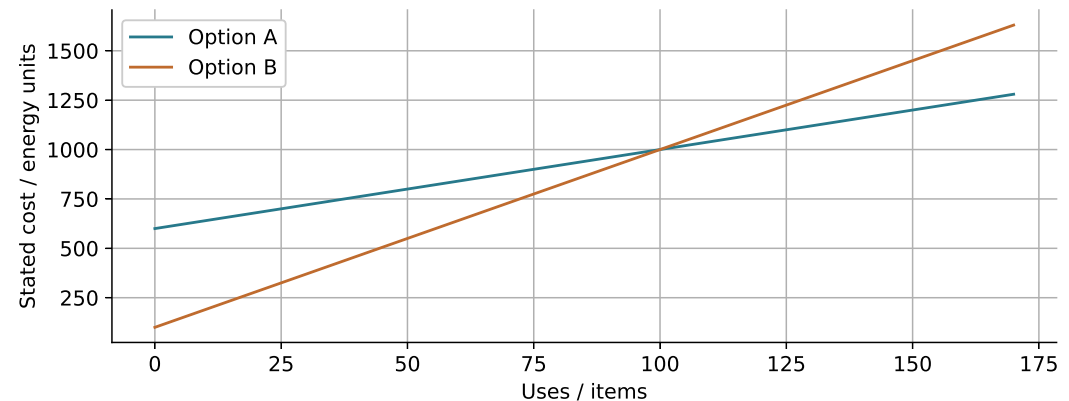
Design sustainability and production choices

■ What would explain this observation?

- A repairable product may cost more initially but stay in service longer. A design decision needs evidence across manufacture, use and disposal.
 - Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.
-

■ Build the model

- **Design for disassembly** supports separation of materials and replacement of parts. Manufacturing choices depend on production volume, **tolerances**, material properties and cost. Sustainability includes environmental and social effects.
- design for disassembly: Design supporting separation and replacement of parts; tolerance : An allowed dimensional variation.



■ Choose evidence that can test it

- Compare a common service over a stated lifetime. Separate fixed tooling cost from cost per item. Include repair, energy, transport and realistic end-of-life pathways rather than using a recycled label as the whole judgement.
- Create a bill of materials and an annotated assembly plan. Test whether a worn part can be replaced with normal tools. For HL project development, evaluate production feasibility and commercial assumptions against the applicable cohort guide.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: method A costs 600 fixed units plus 4 per item; method B costs 100 fixed units plus 9 per item. Equality: $600 + 4n = 100 + 9n$. Rearranging: $500 = 5n$, so $n = 100$ items. Other quality and sustainability criteria may change the choice.

Example:

Fixed costs differ by 400 units and unit costs differ by 5. Find cost break-even quantity. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- A cheaper process is not automatically preferable. Cost estimates need currency, quantity and assumptions, and prototypes do not prove mass-production consistency.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A recycled-content label establishes the entire product life-cycle impact. This claim is false: A cheaper process is not automatically preferable. Cost estimates need currency, quantity and assumptions, and prototypes do not prove mass-production consistency.

Key:

Design sustainability and production choices: Compare a common service over a stated lifetime. Separate fixed tooling cost from cost per item. Include repair, energy, transport and realistic end-of-life pathways rather than using a recycled label as the whole judgement.