THIS GUIDE IS TO BE READ IN CONJUNCTION WITH QUICK GUIDE TO DESIGN VALIDATION

Pedagogical advantages

Verification is often discussed together with validation. They are closely related activities but each has a different purpose

- Verification considers: Does the design meet the requirements?
- Validation considers Does the built design meet the intended use or application?

Validation is necessary to demonstrate that a built design meets

- the needs of the client,
- the needs of the end-user,
- the design drawings or software model,
- safety standards,
- other compliance standards, and
- the engineering requirements.

Including validation exercises in an undergraduate learning environment helps students understand that the designs that they deliver and build (or someone else builds) must be shown to perform as intended under all design conditions, and that a design should never be left to be proven in operation.

An absence of validation has been the cause of numerous engineering failures, so the presence of validation is demonstrably essential.

Assessment

Validation must be performed on a built design and could therefore be performed as part of a lab exercise or as a validation exercise on a larger student project. In either case, students should develop a validation procedure to test a built product against its requirements specification. Validation should be a necessary part of all final-year projects.

After developing the validation procedure, students could then execute the procedure in a lab setting. Students should be assessed on the developed procedure, the execution and the test results.

Validation can be different depending upon the industry, disciplines and nature of the design. For example, differences will exist between:

- Validation of prototype designs
- Validation of products built on a production line
- Validation of one-off (bespoke) designs

Implementation

Given that validation is a demonstration that a built design meets its design limits and intended use, it is necessary to begin with a documented client brief or requirements specification against which the built design can be tested. This may have been developed earlier in the students' project or could be provided by the educator for this exercise. The student should then develop a validation procedure to test the built design for its intended use under all design conditions. This may be multiple procedures for a complex design coordinated with a validation plan.

The validation procedure should test:

- the design to its design limits and tolerances
- all user interfaces to the design
- any other interfaces to the design
- design features intended to protect against hazards

The procedure should demonstrate sufficient coverage to provide confidence in the operability, maintainability and safety of the built design, and should clearly indicate the pass/fail criteria for each test.

Having developed the procedure, the students should have an allocated lab session, or access to test facilities to perform their validation procedure. The validation results form part of the assessment. It should be made clear that any failures in the validation of the design are not a failure of the validation exercise but are valuable feedback to improve the design.

Indicative assessment

Students will develop a validation procedure that enables the review team to determine that the design meets:

- its design limits and intended use as detailed in the requirements specification and client brief, and
- incorporates safety measures identified by the hazard identification process.

The procedure should indicate pass/fail criteria for each requirement and demonstrate coverage by referring to individual clauses in the specification documentation.

Students will be allocated to a lab session to execute their procedure and will be required to submit their procedure and results for assessment at the end of the session.

Sample instructions

Include with your project documentation a plan for validating the design.
Ensure the plan enables evaluation that the following are met:

- the needs of the client,
- the needs of the end-user,
- the design drawings or software model,
- safety standards,
- other compliance standards, and
- the engineering requirements.

Use the plan to validate the design.

Submit both the plan and a record of the results of the validation activity which implemented the plan with other project documents in line with designated timelines.

Indicative Rubric

	Not Satisfactory	*Satisfactory*	*Very Good - meets Satisfactory criteria plus…*
Validation Procedure	☐ No validation procedure provided or incomplete ☐ Validation procedure fails to test the fundamental intentions of the design	☐ Validation procedure provided Validation procedure includes the following details: ☐ Date, time, name of the tester ☐ Details of the item under test ☐ Details of test equipment ☐ Clear validation steps ☐ Pass/fail criteria ☐ Validation demonstrates coverage of requirements to provide confidence in the built design	☐ Validation explores all aspects of intended use under all design operating conditions ☐ Validation procedure references individual requirements
Validation Results	☐ Validation not performed ☐ Validation results invented or copied	☐ Validation performed in accordance with the validation procedure	☐ Evidence that the results of the validation exercise have been considered and responded to as necessary

Frequently asked questions

1. ***How is Validation different from Verification***

   Validation is to check a built (constructed, assembled, installed; programmed) asset, device equipment or system. Inspection and test plans, witness and hold points, measurements are all validation exercises.

   Verification is prior to construction/building/installing/assembly; that is desk-top checks that the design fulfils its (for examples) specification, standards, codes of practice, user-needs, policies.

2. ***What if the client brief is not complete or clear?***

   The client brief is a critical component of the design process. If it is not clear or complete the designer is not able to design an appropriate solution to the client's problem. This challenge is further complicated where the client is unsure of or has difficulty articulating what the problem is.

   The designer must use their communication and interpersonal skills to draw out from the client the information they need to ensure what they design is what is needed.

   The validation process provides an opportunity before the completion of the project to check with the client whether the designed solution meets the actual needs of the brief.

   The Optimising Problem Solving model ("Optimising problem solving (OPS) pentagon,") has (literally) at its centre problem definition and specifications and the advice that "when in doubt go back to the centre". This model was developed to support the design projects of engineering students. It highlights the need for designers to understand the problem thoroughly before they can ensure they are creating and valid solution.

Further Reading & References

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