DESIGN VERIFICATION IMPLEMENTATION GUIDE

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

Pedagogical Advantages

The Design Verification process used in the undergraduate learning environment develops student capabilities to generate, interpret and apply peer feedback and to develop self-evaluation capabilities. Design Verification:

- Demonstrates that a design satisfies the requirements/specification, and
- Provides assurance that design calculations and drawings correct/free of errors.

Implementation

The Designer and Verifier roles may be undertaken by individuals or teams. The roles of designers and verifiers are different but interdependent.

Designers must substantiate (design verification) that their design satisfies the design requirements (design inputs). Substantiation may be performed through analysis or documentation of engineering justifications to identify how the design complies with the requirements.

Designers must then submit their substantiating artefacts to a Verifier for independent review. Independent review should be after the design is suitably mature and occur before final submission of the completed design (design release) to ensure feedback can be addressed.

Verifiers are not redesigning but ensuring that the designer's substantiation is technically sound and accurate. Verifiers must provide feedback that is informed by appropriate interpretation of design documentation, be justified in relation to relevant theory and design requirements and be expressed clearly and appropriately. Verifiers may also provide recommendations for improvement to both the design and substantiation where relevant.

Designers must address any issues identified by the Verifier. They are not obliged to make changes though unless there is reasonable justification for not implementing the change.

Assessment

As the Design Verification process uses peer feedback for an iterative process of review and improvement, the most suitable assessment tasks are those with several stages such as open-ended design projects. Therefore, any recommendations for improvement can be reflected on prior to the final submission.

Simple calculations, with a single correct solution, are not appropriate. The task should have multiple solutions within a solution space defined by a set of requirements where students are required to substantiate how their design satisfies those requirements.

Depending on the task, feedback from teaching staff is not essential prior to the final submission/design. Marking can be limited to confirming whether feedback was given, considered and used appropriately using a rubric (see *Indicative Rubric*). Teacher time can then be used to design a robust task that also assess technical knowledge and competencies, and to provide informal feedback as students engage in the Design Verification processes.

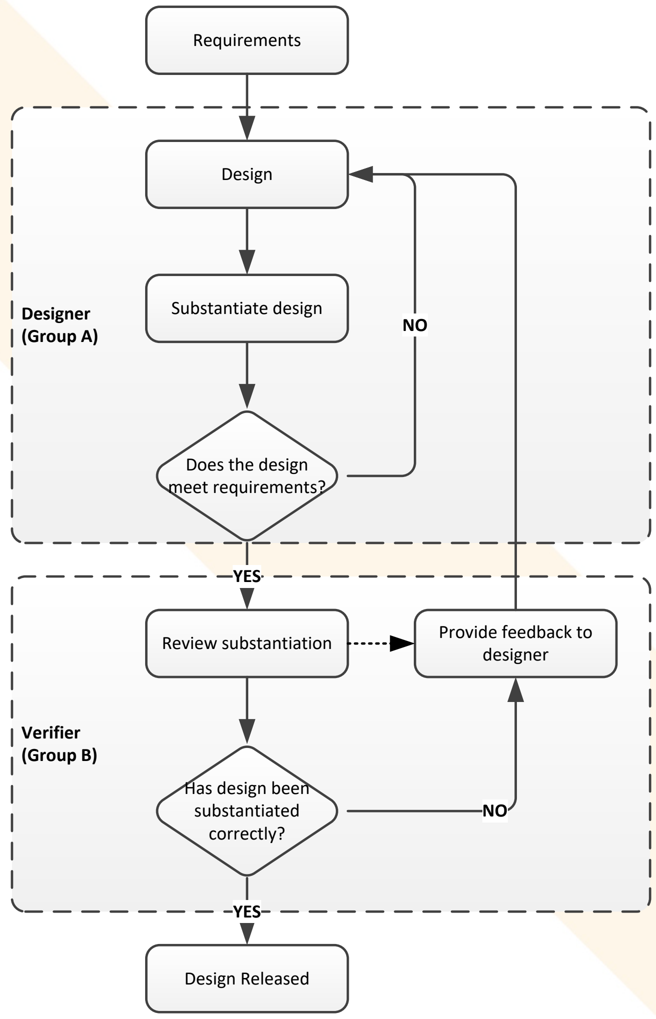


Figure C-1: Design Verification Process

Indicative Assessment

Educators will need to design a task with a solution space defined by a set of design requirements such as optimising the strength-to-weight ratio (as shown in Figure C-2) or similar. The task shall be constructed such that it lends itself to learning the desired engineering curriculum and demonstrating application of the design verification process.

Sample Instructions

Design a solution to a given problem. Your group will be paired with another to review each-others designs.

Each group must:

1. Develop and substantiate a solution that satisfies the requirements.
2. Submit their design to the other group (Verifier) for independent review of their design and substantiation which should include:
   (i) submission cover page (signed by all group members)
   (ii) verification form (only first two columns of the table completed)
   (iii) design substantiation (drawings, calculations, verification statements)
3. Provide review feedback to the other group regarding the other group's design
4. Address the feedback provided from the other group regarding their own design

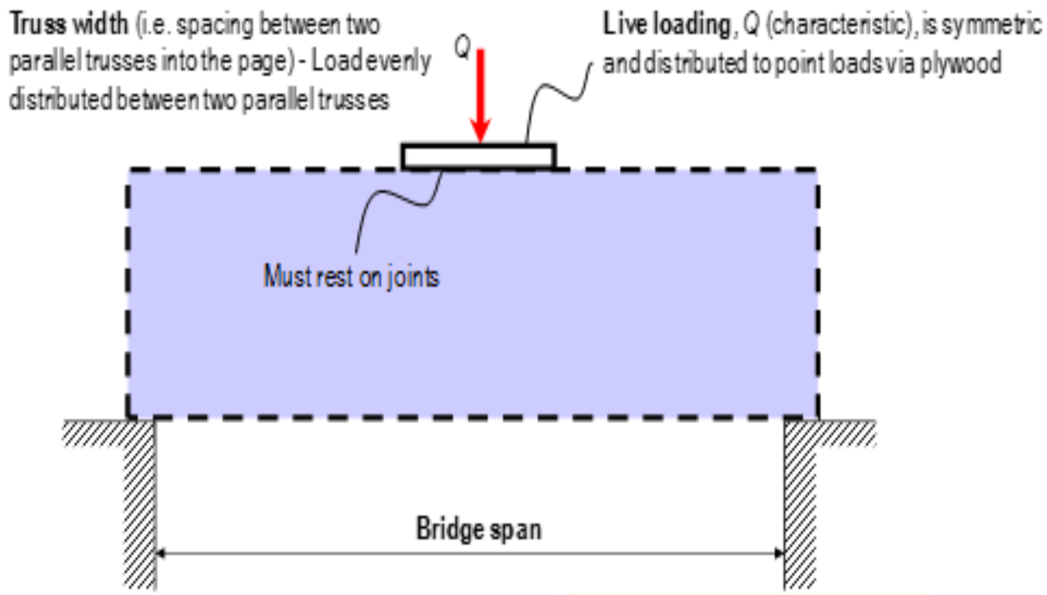


Figure C-2: Example Problem

Indicative Rubric (Design Verification Process)

	Not Satisfactory	*Satisfactory*	*Very Good - meets Satisfactory criteria plus…*
Documentation	☐ Incomplete ☐ Format inappropriate for purpose/Doesn't meet provided standard ☐ Calculations incorrect ☐ Details and extent of verification activities carried out incomplete, missing or incorrect ☐ No, insufficient or inappropriate recommendations for corrections/improvements ☐ Recommendations result in technically incorrect final outputs	☐ Complete ☐ Provided in appropriate format ☐ Calculations correct ☐ Records details and extent of verification activities carried out ☐ Includes recommended corrections/improvements ☐ Recommendations result in technically correct final outputs	☐ Presented in industry standard format
Feedback	☐ Unclear or confusing ☐ Conclusions lack recommendations for correction and/or improvement ☐ Theory not referenced or not relevant ☐ No reference to design intent or design intent incorrectly identified ☐ References to information or issues not included in design documentation and design output as provided	☐ Clearly expressed ☐ Makes recommendations for correction and/or improvement ☐ Recommendations justified with reference to relevant theory & design intent ☐ Confined to design documentation and design output as provided	☐ Demonstrates advanced knowledge of relevant theory ☐ Demonstrates creative/innovative application of relevant theory ☐ Expressed persuasively – strong, logical and appropriately focussed argument to accept recommendations ☐ Recommendations result in innovative final output that meets design intent
Designer response	☐ No or limited evidence that recommendations from Verifier considered ☐ Documentation and calculations remain incorrect or inaccurate following appropriate recommendations from Verifier ☐ Design output as documented will not meet design intent despite appropriate recommendations from Verifier	☐ Documentation references feedback ☐ Documentation includes justification for accepting or rejecting recommendations from Verifier	☐ Designer and Verifier engage in respectful, professional, robust and informed exchange of ideas ☐ Designer reports back to Verifier what actions have been taken, justifying decisions

Frequently asked questions

1. *What about plagiarism or students who see this as imposing on them ideas not their own?*

The objective is for students to see other design options and points of view to generate potential for self-evaluation and reflection. Students don't need to accept the feedback provided and must justify their response. They can't then take the work or ideas of others without acknowledging their source and therefore avoiding plagiarism. Only minor changes and corrections are required as a result of the verification rather than a redesign. The teacher may spot-check calculations but are not essential.

2. *When should it be conducted in the assessment cycle?*

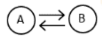
As a guide, the verification process should be late enough in the assessment cycle to ensure that any opportunity for plagiarism is minimised (students must focus on improvement to their own design rather than attempting to completely copy another design), but with enough time to allow modification to the design if necessary through reflection on the peer feedback.

3. *Is 'closing the loop' essential to this process?*

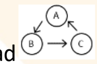
No, this is optional. 'Closing the loop' involves the designer documenting to the verifier the change(s) made to the design (i.e. corrective actions taken) in response to the peer feedback. For education purposes, evidence of these 'corrective actions' have been demonstrated by the Designer's final documentation. It is important that students are aware that in industry the loop is always closed.

4. *How should students (groups or individuals) swap their work?*

It is recommended that swapping be randomised to ensure that students do not simply choose to exchange with their friend(s). For example, students can either directly switch their work



or the switch can occur within a triad



. Triads also provide an additional perspective, as groups give and receive feedback from different groups. However, triads are more complex for the teacher to administer.

5. *Is one hour long enough for students to complete the process?*

Although a short turnaround time for submission is consistent with industry requirements, the actual submission deadline may be significantly greater than one hour (e.g. 24 hours) so that students can feel more comfortable with the reflection process and type their submission (rather than completing by hand) if desired. The Verification process and drafting of feedback though can be completed in a one-hour teaching session, as the objective is to provide recommendations for improvement rather than identify new designs.

Frequently asked questions (continued)

6. How much guidance should be given to students upfront?

The level of guidance is generally at the discretion of the teacher. Demonstrating the process and standard of documentation using an exemplar is recommended before students perform the Verification Process for the first time or if student responses indicate further explanation is required. Subsequent practice may only require a verbal introduction. It should be noted that any learning activities and assessment tasks should be accompanied by clearly expressed explicit instructions and criteria for success. For most teaching environments used to date, the 'less is more' approach has been very successful in encouraging student curiosity, innovation and independent study.

7. Does this make a difference to students?

Student perceptions of design verification process, based on responses from over 300 students for three representative course offerings, indicates students have found this approach beneficial (Willis et al., 2012)

Survey statement	*Broad agreement (mean)*
Verification improved my understanding of the importance of checking designs.	*92.7 %*
Verification improved my understanding of the technical concepts in the course.	*87.7 %*
Verification feedback allowed improvement of the final constructed truss model compared to its original design.	*80.7 %*
Constructing and testing the truss model improved my understanding of the importance of checking designs.	*91.7 %*

Peer assessments have improved student learning through increased reflection and engagement and placed emphasis on both giving and receiving feedback (O'Moore and Baldock, 2007; Li et al., 2010).

Students used peer assessment processes to see other possible solutions and sources of error (O'Moore and Baldock, 2007).

Cyclical feedback strategies increased student engagement with, and reflection on, feedback prior to application in the next step (Hounsell et al., 2008; Quinton and Smallbone, 2010).

Further Reading & References

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