

Individual Research Paper



ENGN2225 Systems Engineering Design

Accessible Door—Verification& Evaluation

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Abstract

This research paper looks at how verification and evaluation in a system work in the whole project life cycle. The background part illustrates how the five testing methods play an important role in a verification process and how to use an Evaluation Matrix to assess the best solution of the project. The project in hand is the accessible doors project. It aims to provide easy access doors especially to customers with wheelchairs, walkers, or babies of the Belconnen Community Centre. Making verification is a very efficient way to optimize the former design of an engineering system. For our project, accessible doors, we will be implementing verification and testing techniques to our design in order to test its capability and validate it, through a series of prototyping and simulative tests. The adjustment that need to be done will be decided by creating an Evaluation Matrix, analyzing the options we had, as well as choosing a best option.

Literature Review

The Third Edition Australian Design Rules (ADRs) are national standards for vehicle safety, anti-theft and emissions (Australian Government, 2014). This standard applies to vehicles newly manufactured in Australia or imported as new or second hand vehicles, and supplied to the Australian market (Australian Government, 2014).

In the third edition of ADRs, the vehicle safety is considered as the most important attribute as well as the prior customer requirement. It lists the production quality standard of every core component of different types vehicles respectively, and rules the vehicles to do the

compulsory inspections during the whole product life cycle. To realize the maintenance and a long lasting safety using of the vehicles, the government applies the Type 4 testing (Support testing) method to enhance the pass standard and the inspection events to meet users' requirements.

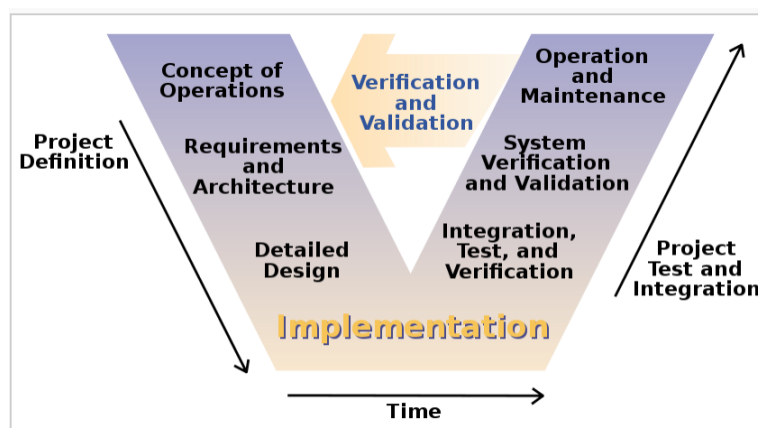
Project Background

Our Accessible Doors Group has already drafted a plan on how to improve the current front door of the Belconnen Community Centre. Considering of the surrounding and the unique angle of the corner between the front door and glass wall of the Belconnen Community Centre, we still need to make some improvements to our present design. Noticing that many customers of this centre are disables, and many women have to try hard to push the manual door while holding their babies on the arm, we are going to change the door into a automatic one. An mechanic arm will have to be added to the top of the existing door, a sensor will needed to be set on the outside of the door, and as client required, we will connect our system with the existed card swiping system of the building.

Theory Review

Verification and validation are mainly used to assess the system's capability of the implementation and work as a feedback to enhance the project design by going through several project testing and integrating steps. Figure 1 demonstrates the relationship between project design, implementation, and verification.

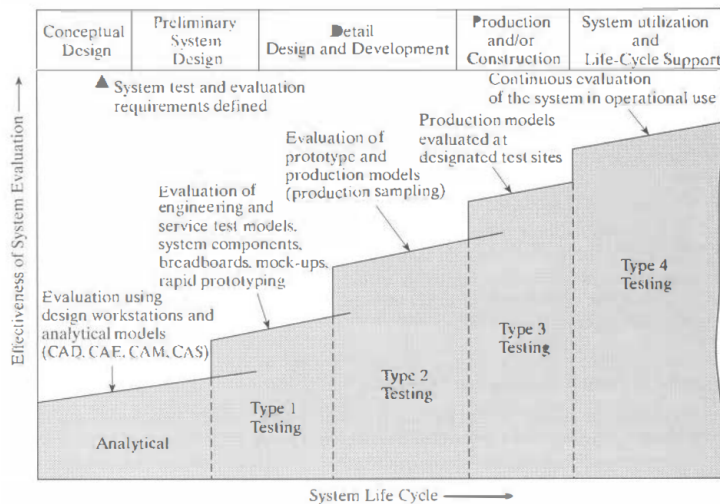
Figure 1. The V-model of the Systems Engineering Process



Source: Clarus Concept of Operations (2005, Figure 5).

There are five typical testing types, they suits on different stages of the project lifecycle. As the Figure 2 shows below:

Figure 2. Stages of System Test and Evaluation During the Life Cycle



Source: Systems Engineering and Analysis. (2011, Figure 6.2)

1. Analytical testing is an utilization of analytical models, such as CAD methods, before the design is finalized (Blanchard, 2011).
2. Type 1 testing (Proof of concept) is always used to test the application of rapid prototyping during the initial phases of detail design (Blanchard, 2011).
3. During the latter part of the detail design when preproduction prototype are available, Type 2 testing (Prototype testing) are accomplished to optimize the prototype that has not necessarily been fully qualified (Blanchard, 2011).
4. After the design is finalized, and ready to be put out in the market, Type 3 testing (Operational testing) is used to test the qualification of the product by doing a continuous testing is over an extended period of time (Blanchard, 2011).

5. To actually assess the product’s true capability in the customer environment, Type 4 testing (Support testing) are conducted after the products are put into the market by continuing collect users’ feedbacks to ensure the long lasting operations of the system (Blanchard, 2011).

When the original design is validated to be not suit the clients and design requirements, Evaluation Matrix can be a good way to weight all possible solutions and to identify the best one of all.

Application

1. Testing Methods

In this stage of designing, the Type 2, Type 3, and Type 4 testing can not applied in our project, so our project group mainly focused on the first two types.

First of all, the partly cascade table below shows the attributes of our accessible door project:

Table 1. Partly Attribute Cascade Table for Accessible Door in Belconnen Community Centre

Primary attribute	Secondary attribute	Tertiary attribute	Related subsystem
A1.0 Open automatically during trading hour	A1.1 People can be sensitive when they come	A1.1.1 Available sensor in front of the entrance	Safety and user friendly/door/open action/money
	A1.2 Open with an appropriate width before people come very closed	A1.2.1 control the distance between sensor and door	Safety and user friendly
		A1.2.3 control the opening speed, angle, and duration time	Safety and user friendly/door
	A1.3 push bottom to open when people want to leave	A1.3.1 available bottom install in a suitable position(not too high)	Safety and user friendly/ open action

Based on the attributes table we have made in week 7, we did a formal test in proof of concept level for the attributes A1.2.1, and A1.2.3, (mainly related to safety and user-friendly). We regard the front door of the emergency entrance in Calvary Hospital, which can meet most of our client's requirements, as a rapid prototyping.

Test person: customers with wheelchairs, walkers

Procedure:

1. Walk towards the building from outside.
2. Active the sensor.
3. Walk in and keep moving until the door is closed.
4. Walk back towards the door.
5. Open the door from inside/ press the button/swipe the card.
6. Walk out and keep moving until the door is closed.

Pass/Fail Criteria:

1. Enough space for the customer to go through the door from out side without a hit or crush;
2. An appropriate time duration allows the people slowly pass the door;
3. Close as soon as the customer leave the dangerous area;
4. Customers can easily reach the button or card swiper to make the door open;
5. Avoid unnecessary opening.

So far, there are three possible options, namely, card&sensor, button&sensor, and sensor only door, however, noticing that the reception of this centre is closes to the door, the sensor only door can not avoid unnecessary opening when customers walking around. To this end, the sensor controlled only door was failed in this test.

Furthermore, the pairwise analysis table was used to rank the top five customer requirements, and according to this, an Evaluation Matrix can be generated as follow:

Evaluation Matrix

SCALE

5=Exceeds compliance; 3=Full compliance; 1=Partial compliance; 0=Non-compliance.

CUSTOMER REQUIREMENTS	WEIGHTING		CARD&SENSOR		BUTTON&SENSOR	
	RANKING	WEIGHTING	RELATIVE COMPLIANCE	WEIGHTED VALUE	RELATIVE COMPLIANCE	WEIGHTED VALUE
Time and Cost	4	2	5	10	3	6
Exterior Appearance	5	1	3	3	1	1
Energy-efficient	3	3	1	3	3	9
User-friendly	1	5	3	15	1	5
Quality and Safety	2	4	3	12	5	20
TOTAL				43		41

Considering that there is already a existing card system in Belconnen Community Centre, the project group was tend to use this convenience, plus, the card and sensor door gains the higher score in the evaluation matrix, we eventually choose the card and sensor door as an optimal solution.

Discussion

During our test, first of all, we found that the tested person have to be protected from injury carefully, since there is a door stage right under the door, and people who with wheelchair cannot exactly get through by themselves. So, although the client did not specially put

forward a safety requirement, this issue must be considered and an alternation needs to be come out to enhance the door's safety level. Secondary, though a sample door has been used as a reference, there are still a lot of reformation of it needs to be done before we make it a prototype of the project. We may face a lot of professional questions during this process, such as the connection between the automatic system with the existed card swiping system, the safety guarantee with the client's requirement of no CCTV, the adjustment of the maximum opening angle of the door (because of the strange angle between the door and walls), etc. Furthermore, we may need a professional mechanical engineer to solve some of the problems, including the installation of the automatic arm, and the problems that have been mentioned before.

Conclusions

Good verification is vital to the reformation of the existing door, so that the original design can be adjusted to a better level and everything have been done formerly can be checked at each stage to make sure everything will work well in the end. This will help the project group to better meet client's needs. As for evaluation, several options have been figured out to improve the current door, however, only the optimal one can be chosen to be the final decision. Thus, the evaluation techniques such as Evaluation Matrix are quite useful to make the best choice.

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Peer Review Critique

(Only one student did a peer review for me)

Aspect 1

Grade: Outstanding

Comment: The author has written most if not everything that this individual research paper requires. One thing to keep an eye on is the page limit which is between 4-5 pages long and not exceeding 1500 words.

Aspect 2

Grade: Outstanding

Comment: The author came up with ideas to test the accessible door and then record it down in an evaluation matrix to choose the best option for his/her customer. All these are necessary steps in verification and evaluation analysis.

Aspect 3

Grade: Outstanding

Comment: The author has successfully applied the theory mentioned in the theory review section into his/her own project.

Aspect 4

Grade: Outstanding

Comment: The author came up with his/her ideas of improvement to increase security and safety of the door. The author has also acknowledged that he/she may require experts' point of view to solve a few problems that the author's group may not be capable of.

Aspect 5

Grade: Outstanding

Comment: Good quality and updated bibliography.