Standard : 91612

Demonstrate understanding of how technological modelling supports technological development and implementation

What is functional modelling?

Technological modelling is a form of modelling that allows for a potential design to be thoroughly tested for functionality by using techniques such as Computer Aided Design (CAD,) sketching, card modelling, test rigs, or 3D Printing. This is in attempt to minimise any potential problems or issues with a design before it is put into the production stage.

Each different type of modelling can be used to test different aspects of the function of a product. For example, test rigs test the durability and longevity of a product, while 3D printing tests the ergonomics and potentially the full functionality of the finished product.

<u>What is prototyping?</u>

Prototyping is the creation of a physical model. This is done so that the designers can get their hands on their design to test its functionality (or lack thereof) so that corrections can be made prior to production. It is commonly used for products that are required to be used hands on. E.g. remotes, a steering wheel for a car (Fig 1.2), a computer mouse, or even a drill (Fig. 1.1) etc.
Prototyping allows the designs kinks to be minimised prior to its production. It saves time, resources, materials, money.

<u>How I've used prototyping in my work this year</u>

In my work this year I have been using Solidworks and 3D printing to visualise and test my work.

I've been using 3D printing to test functionality in my design while minimising the materials used to save time and money. For my project specifically I have been printing test pieces of a target holder for Airsoft guns. 3D printing has allowed me to print a functional model to test the dimensions for holding tin cans and plastic bottles. Without prototyping my dimensions using FDM printers my dimensions may have worked (which I found out with my first test piece Fig 2.1) But it wouldn't have been an ideal fit which is what I was striving for. The small adjustments I made using information I found through the protoyping has allowed me to make a more functional final product (Fig 2.2). It has also allowed me to test to test various aspects of my design. Does it stay still when BB's impact? Does it stay together? Is it easily damaged when BB's impact it?

Example of prototyping, Fig. 1.1
http://www.3dfuture.com.au/wp-content/uploads/2011/05/DSCF1126.jpg

Example of a final prototype, Fig 1.2
http://www.automotive-eetimes.com/images/01-edit-photo-uploads/2014/2014-10-october/porsche/m14_4307_fine.jpg

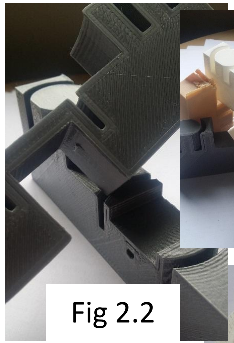

Fig 2.2

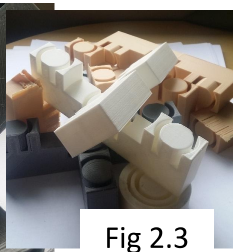

Fig 2.3

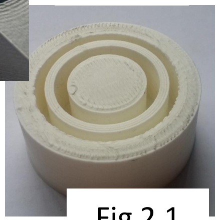

Fig 2.1

How prototyping is used to improve a product?

Each different type of modelling presents a unique way to test a designs suitability for its task prior to its production. An example of this are test rigs (Fig 3.2-3.3)

For example Toyota Motorsport have a 2,600m² testing facility in Germany where they stress test all aspects of a high performance car such as the transmission, suspension, steering rack, and so on. The stress testing allows them to find structural and functional problems with the their race car parts before they make the car to find out if the suspension is stiffer than the lid of a new jam jar or if it'll break within 30 minutes of racing. The information gained from this process allows them to improve the performance of not just their race cars but it could also help them design their road cars too and so they are improving their product with an informed decisions.

Another example is the use of 3D printing in design. I myself have been using 3D printing for the past couple months (Fig 3.1) to test functionality in my design. By using the 3D printing I have been able to identify and perfect the various size, weight, ergonomic, and size problems in my work in a way that minimises material usage and lets me make informed decisions to improve my design.

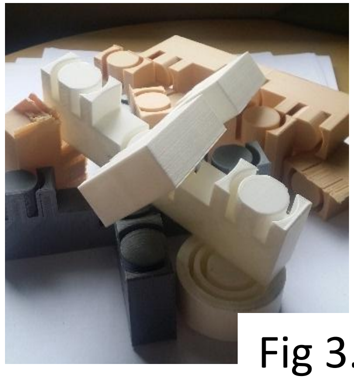

Fig 3.1

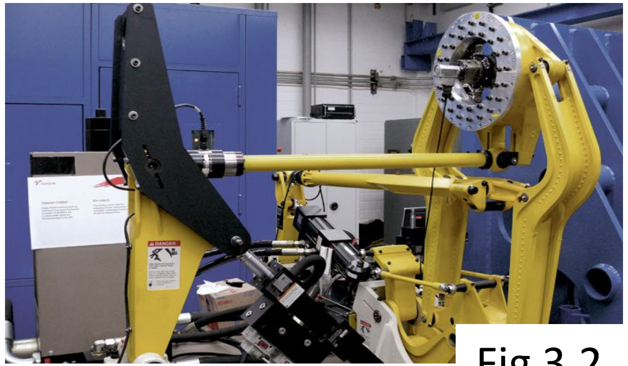

Fig 3.2

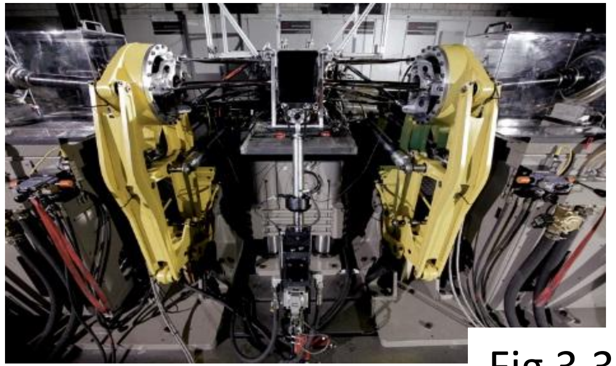

Fig 3.3

Information and images : http://www.toyota-motorsport.com/en/services-en/research-development-en/component-test-rigs-en

Images and information

http://www.carbodydesign.com/gallery/2014/09/2015-mustang-from-sketch-to-production/

http://www.carbodydesign.com/2014/09/2015-mustang-from-sketch-to-production/

How can clay modelling assist a design?

One of the forms of functional modelling that was used in the design of the new Ford Mustang were full sized clay models of both the exterior and interior body shapes.

Clay is used because it allows the designers to create a physical recreation of their sketch ideas. Clay is cheap which is a desirable factor because it reduces design cost. As well is being cheap it is also extremely versatile as it can be moulded to almost any shape which makes it perfect for almost any type of modelling.

The primary use of clay modelling is to allow the designers of the product to see and feel a 1:1 scale model of their design.

With this model they can then make changes according to their opinion and it helps them to avoid any design flaws in a cost effective, affordable way before the design process moves forward. Using the 1:1 scale model it can also allow the designer to tick off any design specification points relevant to aesthetics, ergonomics, and also functional points at a relatively early stage in the design process.

For the Ford Mustang design team specifically the use of the Clay modelling gives them a hands-on approach to influence and change their design. The shape of a car like a Ford Mustang is a big deal. It must set a certain tone and possess the DNA that makes a Mustang a Mustang. The use of clay models allows the design team to analyse a physical representation of their designs and make any changes to it on the fly as they see fit to ensure to meets their specified requirements and so avoid any issues further down the line that may have occurred from neglecting to use a form of functional modelling like clay.

It also helps them to plan the logistics of the required parts of the car. How is the engine going to fit? Does the driveshaft sit flush? Do the seats have enough room for adjustment? How does the shifter feel? These questions could go on for hours and the clay modelling is what allows them to answer many of these questions. The nature of clay means they can make any changes they believe are required.

The fact that this modelling can easily be 1:1 scale makes it perfect for modelling a product like a Ford Mustang. It possesses the ability to make changes on the go and helps them to create a car that works for people of all sizes and fulfil their wants and needs.

What have I learnt from this?

There is a potential for the use of clay modelling it terms of a guitar case for my work in Term 2 and 3. I could (like the mustang design team) make a 1:1 scale of my case design so that I can see how it functions as a storage space.

It would provide an accurate representation of the actual size of one of my designs and help me decide if it’s practical in that sense. It would also give me an insight into the ergonomic functionality of my design.

I believe it has limitation however. In regards to testing ergonomics it would likely be limited to how it functions when packing/unpacking the case but the nature of clay would make it difficult to test ergonomics in terms of how it feels to carry and how it fits in the car, etc. In terms of testing function it would also be limited to testing the functionality as a storage space as it doesn’t represent the protective properties of a wooden hard case which is another down side.

Researching clay modelling has broadened my thoughts to other types of modelling. It has made me appreciate where full 1:1 scale functional modelling is most useful and has alerted me to the risk management aspects that allow me to check off many of the design specification without making a full-on prototype. I now also know where clay modelling has its disadvantages in it’s function for certain types of designs. Knowing this helps me make an informed decision on the prototyping aspects of my designs.

Fig 4.5

The process Lincoln Cars went through to design a Limo steering wheel
Clay -> 1st design -> final design

Images http://now.lincoln.com/wp-content/uploads/2012/12/newpost2-4.jpg

Information on Dyson Rapid Prototyping - https://www.plm.automation.siemens.com/en_sg/about_us/success/case_study.cfm?Component=30382&ComponentTemplate=1481

Source for screen captures : https://www.youtube.com/watch?v=nlCLNZq3vC4


Fig 5.4


Fig 5.5

How is this 3D printing used?

One of the most modern ways we can model a design is using 3D CAD software. Making a 3D render of a product can be useful in two ways. You can see your design come to life on the screen with the incredible detail achieved through computers. But more importantly you can then turn the 3D representation on a computer into a physical scale model with the click of a button, that is the rapid prototyping aspect. The use of both SLS (selective laser sintering) and FDM (fused deposition model) printing solutions allows for an fast, extremely accurate (if not cheap) prototyping method. You could have a rough design in a sketchbook in the morning and have an extremely accurate 3D Physical model in your hands by that evening.

For Dyson, it allows them to go from sketching -> card/foam modelling -> extremely accurate plastic model very quickly. The accuracy in the plastic models can them allow them to fine tune their design prior to the production stage by simply altering the 3D CAD file and reprinting.

The primary use for rapid prototyping through CAD modelling is to get a hands on feel for a design. Just about any product can be 3D printed as a means of testing in the design process. Designers can use 3D printing software to quickly create a durable, physical representation of an idea. Using a 3D model they can then make informed decisions for the future additions or changes to a design regarding ergonomics, function, and aesthetics.

When designing something like a vacuum cleaner two of the most important aspects would be the ergonomics, and the durability. For Dyson, the ergonomics of their product is very important. Having a 3D representation can allow for the designers to get their hands on a 1:1 scale model of a vacuum design (bottom-right picture) and figure out what does and doesn’t work on their design so that they can adjust their design accordingly is a very important point in their design process and rapid prototyping is an easy way of doing so.

The durability aspect of their designs can also be tested through rapid prototyping. The materials that 3D printers use aren’t so different from those used in the final product. A fully functional 3D printed model can allow them to find weak points it the design which then allows them to re-evaluate that aspect of their design. This supports the risk management side of design and assists in their decision making.

Using the information gathered from this form of testing it allows the designers to make an informed decision on where the design can go from this point. Do they scrap the idea? Does it need to be reworked? How can the ergonomics be improved? Does the design have a future?

What have I learnt from this?

There is a valid use for 3D printing in my design process for my guitar hard case that I am designing for the advanced skills standard (as seen in the following slides). Whether it be creating a full sized model of one of my designs or using it to create simpler aspects of the design whether that be to simulate some of the contents, such as the pedals, or pick holders. Or I could even model a part to hold the guitar leads. Maybe even modelling hinges for the lid? Handles? The possibilities are there and available to me.

3D modelling a full sized case could be a useful endeavour for me. It would allow me to analyse how the product works as a storage space, and I can also test the ergonomics aspects of a guitar case. I could carry it around, see where and what it fits, and where/what it doesn't. It would also be very useful to me to prototype and test the ergonomics of things like the handle or the method of attaching a lid.

The limitations for me using 3D modelling would be the cost factor. I can't justify the cost of bigger 3D models for purposes of what I'm doing, especially since the facilities available don't provide the ability to model something that is over 1m long which would mean outsourcing it which could get pricey.

Researching further into rapid prototyping has allowed me to see the various ways in which I could practically implement this method into my design work given the availability and ease for me to do so. I believe that the use of 3D modelling with influence my future work on this project.

Fig 5.6

Fig 5.7

What forms of technological modelling have I used to assist in the design of my product?

In the development of my guitar hard case design for my conceptual work the two most useful tools in the form of technological modelling I used were whiteboard/card modelling and CAD (computer aided design) modelling.

<u>Whiteboard/Card</u>

I utilised the 1.2x1m whiteboards in the second stage of my design, right after my sketching. I used my favourite sketching design as a base for the shape of the case. Then, using my actual guitar, and the items that are to fit into the case, I drew an outline around my guitar of the whiteboard and cut out card shapes of all the pieces that need to fit inside the design. This meant that I could freely move around the card pieces until I achieved an economical design that will fit my design specification. At this point I then drew a shape around all of the components using my sketching as a guide. (Fig 6.1-6.2)

<u>CAD</u>

Once I was happy with my whiteboard design I then used a ruler to record the dimensions of different parts of the case. This then allowed me to use Solidworks to 3D model my whiteboard design and allow my to explore the design from all perspectives. (Fig 6.3-6.4)

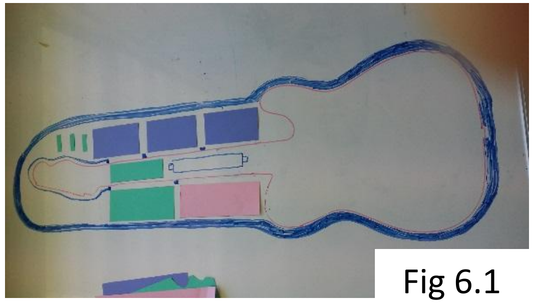

Fig 6.1

Fig 6.2

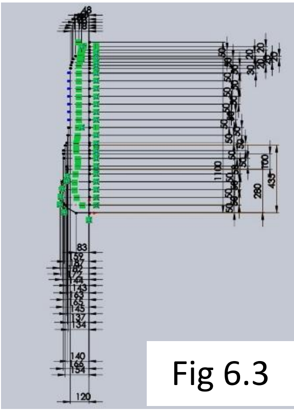

Fig 6.3

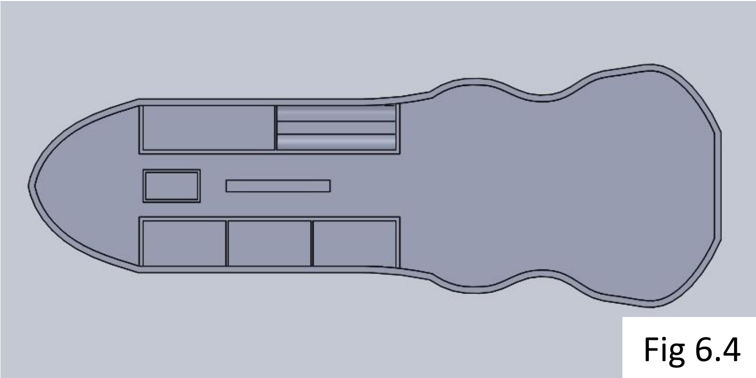

Fig 6.4

How did technological modelling was used to answer questions about my design? How did this help me make changes and progress my design?

Whiteboard/card

Using the whiteboard allowed me to prove that my designs I had sketched were not practical because the dimensions of my items wouldn't allow for my design shape in the way they were arranged. Once I had identified this I could then alter my initial sketching designs using the whiteboard as it allowed me to quickly change aspects of the design that would have otherwise taken longer in CAD or cardboard modelling.

One of the compromises I realised I had to make was the change the tip of my design to be more rounded. I found out it had to be changed by tracing the sharpest bend that could be achieved with flexi-ply (Fig 7.2) and then comparing it the bend to my initial whiteboard curve taken from my sketches (Fig 7.1.) I then knew that I could not achieve that sharp of a bend and I adapted a new design (Fig 7.2)

Using the whiteboard allowed me to think about what the important aspects of my design are and prioritise them. Using the speed of which I can change my design using the whiteboard and card I could rethink my design quickly in a way that would allow me to see the changes. This meant I could go through many different designs until I found one that fit the requirements. (Fig 7.3)

Using this form of modelling allowed me to slim my design by arranging the internal storage spaces using proper 1:1 scale dimensions, ensure that my design could be made and quickly alter it accordingly, obtain dimensions to allow me to lead onto CAD modelling easily to further develop my design.

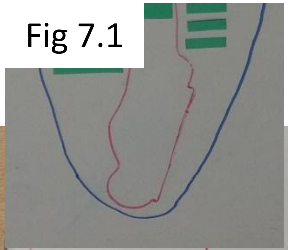

Fig 7.1

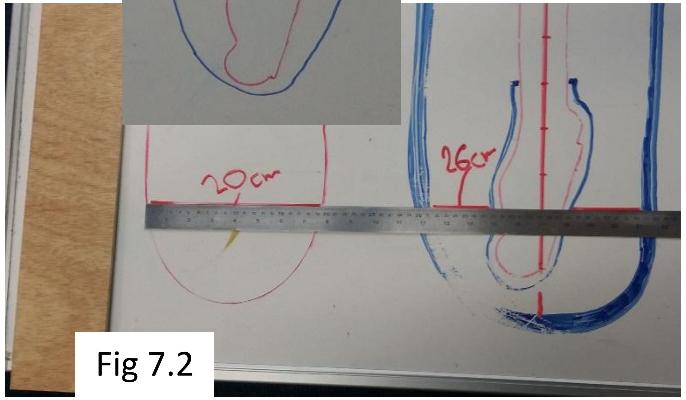

Fig 7.2

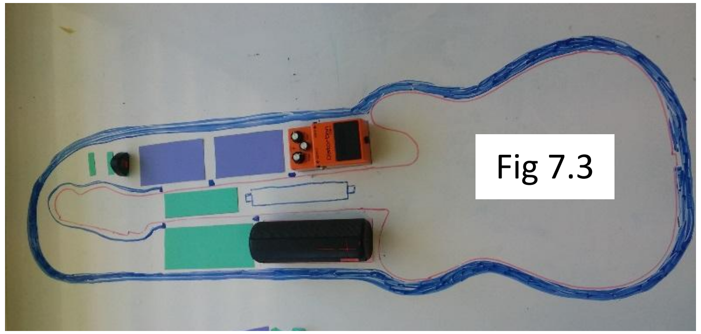

Fig 7.3

How did technological modelling was used to answer questions about my design? How did this help me make changes and progress my design?

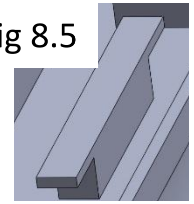

Fig 8.5

CAD

Using CAD modelling allowed me to prove many things. Firstly, it allowed me to check certain things off of my design specification. For example, Solidworks gave me a weight estimate for my design (Fig 8.1), it also allowed me to get more accurate dimensions to ensure that the design would fit into my environment thus proving that my design was going in the right direction. Secondly, it allowed me of see a 3D representation of my final whiteboard design which allowed me to critique certain aspects of the design and change them while modelling.

One of the compromises I found I had to make while CAD modelling was that on my whiteboard design I hadn't left enough room between the guitar neck and the items for an enclosure to be made around them (Fig 8.2.) So I had to increase the width of the neck space to accommodate an enclosure for the items (Fig 8.3.)

Using 3D CAD modelling allowed me to realise my design had a flaw. It went from having small, single point guides to hold the guitar in place (Fig 8.4) and allowed me to redesign the neck brace which cups it, giving it support from the sides as well as the bottom of the case.

It also let me see that there were other potential problems with construction that I have now managed to avoid (example in paragraph 2.) This shows that the CAD modelling has made me think deeper into the construction of the design which means that I will hopefully minimise mistakes made when making the product.

This form of modelling has also lead me into doing some testing in the workshop. For example, I made the guitar lead holder (Fig 8.5 + circled in Fig 8.3) in the workshop which allowed me to see that the holder was too tall and so I then went back to my CAD model and made appropriate changes.

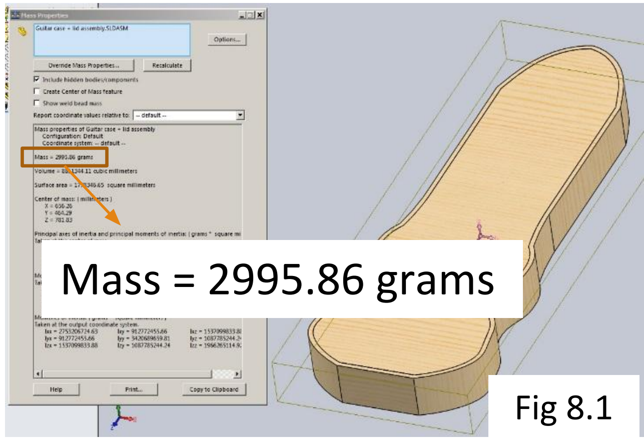

Fig 8.1

Fig 8.2

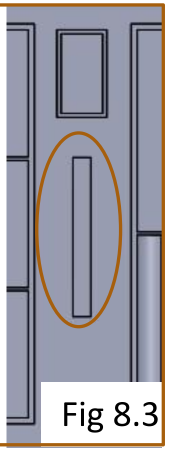

Fig 8.3

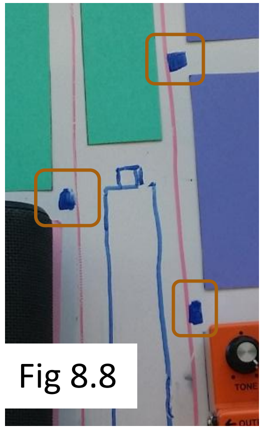

Fig 8.8

Assessment Schedule, 91612 Demonstrate understanding of how technological modelling supports technological development and implementation		
Final grades will be decided using professional judgement based on a holistic examination of the evidence provided against the criteria.		
Issues from the Specifications Where a candidate has provided a brief answer, the answer should not be penalised because of length. Candidate work in excess of 10 pages must not be marked. Where a candidate has used a small font markers should make a judgement about where to stop marking. This judgement should be made relative to 10 pages of Arial font Where work is illegible, it cannot be marked. Digital submissions that cannot be read cannot be marked.		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Demonstrating understanding of how technological modelling supports technological development and implementation involves:	Demonstrating in-depth understanding of how technological modelling supports technological development and implementation involves:	Demonstrating comprehensive understanding of how technological modelling supports technological development and implementation involves:
explaining how functional modelling is used to test competing and/or contestable factors to inform decisions during the development of a technological outcome explaining how prototyping is used to inform decisions for implementation of a technological outcome.	explaining how evidence regarding competing and/or contestable factors is gained from different forms of modelling to justify decisions made during the development and implementation of a technological outcome.	discussing how modelling enables informed, responsive, and defensible decision making during the development and implementation of a technological outcome.

Grade: M

The candidate has explained in some depth the different forms of modelling used in a range of technological activity. Functional modelling and prototyping have been differentiated using a number of examples with school-based project work linked in with external case study material. The approach used in the presentation produces a rather disjointed structure which has, unfortunately, affected the overall focus of the report.

Technology Schedule Appendix 1

<table>
<tr><td colspan="2">Markers must exercise professional judgement to decide if a report demonstrates understanding. The following appendix provides guidance for markers making this judgement.
A report must use information to demonstrate understanding.
Reports described wholly or substantially by one or more of the statements in the left column demonstrate understanding.
Reports described wholly, or substantially, by one or more of the statements in the right column do not demonstrate understanding.</td></tr>
<tr><td colspan="2">Where the report is made up of both used and reproduced information the marker must decide if the report is successful against the standard when the reproduced information is ignored.</td></tr>
<tr><th>Evidence of use of information</th><th>Evidence of reproduction of information</th></tr>
<tr><td>Candidate’s report describes and explains the candidate’s use, in their practice, of information relating to the standard</td><td rowspan="2">Information is presented in isolation from the candidate’s Technological experiences. It offers nothing or little to suggest the information is related to a course of instruction at level 8.</td></tr>
<tr><td>Information from the candidate’s practice, research, the practice of others, and teaching is related to the candidate’s technological experiences.
The report describes experiences you would expect to come from a course of instruction derived from The Technology Learning area the NZC.
These could include but are not limited to
• testing and trialling within a modelling process
• developing a conceptual statement
• developing a conceptual design
• development of a brief
• material selection
• refinement of a brief
• development of a prototype
• development of a one off solution
• further examples may be added.</td></tr>
<tr><td>Information from research, the practice of others, or teaching is reported in the candidate’s own voice.</td><td>Information is not in the candidate’s voice. The word choice, sentence structure, sentence length, punctuation and so on are not what a candidate could be expected to produce.</td></tr>
<tr><td>Referenced, complex research information unchanged by paraphrase is related to other information in a manner that unambiguously constructs meaning. (very rare)</td><td>Unreferenced, complex, research information is presented as though it is the candidate’s own work.</td></tr>
<tr><td colspan="2">Where the marker suspects a report is a deliberate attempt to deceive the report should be referred to the panel leader using the Irregular Booklet process.</td></tr>
</table>