sustainablySMART

Sustainable Smart Mobile Devices Lifecycles through Advanced Re-design, Reliability, and Re-use and Remanufacturing Technologies

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DEM = Demonstrator, pilot, prototype, plan designs
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Disclaimer

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Summary

This Deliverable is the final report of the work carried out by MicroPro and partners in task 1.6 of the SustainablySMART Project. MicroPro has a long history of working in the design and manufacture of computer equipment based on Circular Economy principles developed over the past 20 years in the iameco environmental range of computers. These developments are well documented in previous articles and reports.

In spite of successful prototype development of a desktop and a laptop model, MicroPro has found it difficult to market these computers viably because of the high costs associated with outsourcing design and manufacture of computers, which makes small-scale, localised design, production and marketing of innovative computers financially unviable.

The aim of task 1.6, of the SustainablySMART Project was to design and manufacture a prototype for an iameco D4R tablet, designed on Circular Economy principles. These design principles were pioneered by MicroPro in previous models. A definitive prototype of the iameco D4R tablet (the Kappa Prototype) has been designed and manufactured. The prototype demonstrates the feasibility of design and manufacture of this tablet, using CAD design and digital fabrication, within a small digital fabrication workshop environment or FabLab. This design and manufacture approach will enable the financially viable commercialization of the iameco D4R tablet for a potentially growing market, starting from small numbers but building up to significant international sales. The commercialization itself is outside the scope of the current project and report, but will be explored in future initiatives already planned. Design of the iameco D4R tablet has also taken into account input from design experiences of other partners in the SustainablySMART project, specifically Fairphone and Circular Devices.

The task as approved in the Description of Work was revised following the project General Assembly (Berlin in 2016). This revision proposed that MicroPro implement the iameco D4R tablet development in two stages: In fact, development has taken place over three stages or iterations.

Alpha Stage – taking place from the inception of the project to month 18, resulting in the manufacture of an interim Alpha Prototype. The work leading up to the manufacture of the **Alpha Prototype** was covered extensively in the first version of this deliverable (submitted 31.10.16). It is not covered in the current report to avoid duplication.

Beta Stage – a second stage involving the redesign of the tablet to produce an improved Beta design and prototype, running from Month 18 to Month 27. A description of the housing and integrated electronics leading up to completion of the **Beta Prototype** was contained in the second version of this deliverable (submitted 11.11.17) and is also not duplicated in this report.

Kappa Stage - the current report deals with the final stage of development of the iameco D4R tablet. This third and final stage was aimed at adapting previous prototype designs to manufacture in a local digital design and manufacture facility (FabLab equivalent), specifically the workshop of the National College of Furniture Design in GMIT Letterfrack.

This involved substantial change of the housing design and metal frame and local manufacture by the College. This work took place from Month 27 to Month 31, and **the Kappa Prototype** was manufactured and presented at the General Assembly in Oulu, Finland 13.03.18 and the current deliverable report submitted on 03.04.18.
The report also refers to initial work carried out during this period on task 1.7, aimed at exploring and later demonstrating the manufacturability of the iameco D4R tablet in a Fab Lab environment, where **Kappa Prototype** design will be adapted to manufacture by a typical Irish FabLab, at the University of Limerick.

Content

1. Background

1.1 Previous R&D

MicroPro is a small company based in Rathfarnham, Dublin. The company designs and manufactures computers, and provides retail and repair services.

Since its inception in 1991, MicroPro has been working on the design and manufacture of environmentally-friendly computers. In 1999 MicroPro produced its first green computer, the MicroPro Xpc, designed to European Eco-Label standards, which was sold directly from its workshop.

In 2003, MicroPro designed and manufactured the iameco V1 desktop computer, as partner in the LIFE Environment Project HEATSUN.

Later with the support of the Irish EPA's Cleaner Greener Production Programme, MicroPro developed the iameco V3 integrated desktop computer. This model secured the EU Eco-Label for an integrated desktop computers (the first of its kind) in 2010 – EU Eco Label licence number IE/13/001. This model was manufactured and sold in small numbers by MicroPro.

In 2014, as partner in the ZeroWIN Project (FP7), MicroPro designed and manufactured a further prototype for the iameco D4R laptop. The prototype was widely praised in the sector media and won several design awards. However, it could not be manufactured and marketed at a competitive price due to the high cost of commercial outsourcing of design and manufacture.

Currently, as partner in the SustainablySMART project, MicroPro has designed, after 3 iterations, a new iameco D4R tablet prototype, which is designed to be manufactured using local digital fabrication facilities. This method of manufacture aims to bring down the cost of design and manufacture making marketing of this ecological tablet competitive and viable.

1.2 Task 1.6 Description

Task description (from the Description of Work):

- Evaluate findings from former IT designs by MicroPro and from repair of other brands' products
- Evaluate lessons learnt from developing the 2nd generation Fairphone: Transferability of findings and approaches to a tablet concept with respect to:
- (1) Design for reparability by repair shops and do-it-yourself,
- (2) Design for longevity of wear prone components (i.e. battery),
- (3) Design for reliability,
- (4) Design for robustness
- Evaluate reverse manufacturing developments in WP 3 and WP 4 and make the design of the tablet fit to these upcoming processes (criteria: resource and component recovery, economic viability)
- Design for manufacturability in a digital fabrication environment suitable for SMEs or in Fab Labs
- Research the feasibility to use PuzzlePhone modules for tablets
- Test manufacturability of the design in an assembly shop environment, which can be considered a semi-industrial environment

1.3 1st Revision to Task 1.6 (October 2016)

At the 3rd General Assembly of the project (October 2016) held in Berlin, MicroPro explained difficulties encountered with complexity of the housing and electronics design and difficulties to agree with suppliers on specification / production of both housing and electronics.

A new timetable was agreed with the consortium, where at the DoA deadline of Feb. 28th 2017 was set for Deliverable 1.3. By this date MicroPro would deliver an "interim" D1.3 (Alpha Prototype), which would fulfill the key requirements specified in the DoA for the iameco D4R tablet prototype, but would not be the definitive prototype for manufacture.

This Alpha Prototype (AP) reflected the agreed physical concept of the iameco D4R tablet (housing, overall electronic design considering the likely form-factors of the electronic boards and parts, demonstration of cooling concept, consideration of reparability / robustness / reuse / recyclability principles, and in principle demonstrated manufacturability in a small digital production workshop or FabLab. The AP was at TRL 4 demonstrating working assembly and mechanical construction technologies

A further period dating from 28/02/17 to 30/11/17 (Month 27) was agreed with partners, to allow MicroPro to deliver a further iteration of the prototype. At this deadline MicroPro presented the Beta Prototype (BP) as an improved prototype with functional electronics. The BP was designed for digital fabrication in a small workshop, but after an initial review of the BP by selected fabrication producer GMIT, it was felt that the design would have to be considerably amended for such fabrication to take place.

For this reason the BP (presented at the Cyprus General Assembly) and the consequent D1.3 (submitted on 30.10.17) was considered only to be another iteration, on the basis that final iteration of the prototype (the Kappa Prototype -KP) and the report (the current report) would be carried out. The KP would be actually produced in a local fabrication workshop, and delivered by the new target date of 31.03.18. This prototype also integrates functional electronics parts and incorporate all other aspects of the deliverable as described in the DoA.

1.4 Activities towards the Task

28.02.17 (Month 18) - MicroPro delivered an **Alpha Prototype** (AP) to most of the requirements of DoA, but agreed to carry out further improvements and produce a Beta Prototype to incorporate these.

30.10.17 (Month 27) – MicroPro delivered (early) **Beta Prototypes, complete** with functional electronics, building and improving on AP version, as far as housing design. TRL 4 demonstrating integration of functional electronics parts, as well as other aspects of the completed deliverable.

28.03.18 (Month 31) – MicroPro delivered (early) **Kappa Prototype (KP)** re-designed to correct problems in previous prototypes, and manufactured in a local digital fabrication workshop at GMIT. This was presented to the project GA in Oulu on 28.02.18

The **KP** is designed for ease of manufacture (DfM), reducing costs, lead time and improving quality. As part of this contract, GMIT has provided a full-time fabrication designer / researcher (John Gallagher) to work with MicroPro on the iameco D4R tablet during this period.

2. The Prototype Iterations

2.1 The Alpha Prototype

The Alpha Prototype (AP) is designed to incorporate all of MicroPro's eco-design principles of upgradability, updateability, reusability, repairability, recyclability, ease of disassembly, longlife and elimination of most plastics. The Alpha Prototype embodies these principles and is designed to anticipate future changes of components, so the chassis can be used again and again and have many different lives.

It has also been designed so that the mainboard and ancillary components can be replaced using simple tools. Use of glues or plastics other than those embedded in essential components were reduced where possible. The housing was screwed together using standard Phillips type screws.

Design ensured natural ventilation and prevents overheating. Connectivity is maximised. The wooden frame provides a protective standoff for the display. A kill switch is provided for Bluetooth, Wi-Fi, microphone and camera enhancing security.

The AP is manufactured primarily from maple, and has an interior aluminum frame for robustness and stability. The Prototype is fully functional and manufactured to a high specification. The AP exceeded the requirements by providing fully functional electronics, in order to gain the best test advantage.

Assembly of the electronics was carried out in-house. The manufacture was out-sourced to a commercial engineering workshop that uses digital design and CCR manufacture. This commercial outsourcing was an intermediate step, aimed at ensuring that the AP was properly manufactured, and that drawings, specifications and technical aspects were fit for purpose. The AP however, was not the definitive model and was aimed at providing a baseline for further design improvements of the housing, frame and electronic design, as well as manufacture, which has been the basis of subsequent iterations.

Fig. 1: CAD drawing of Alpha Prototype

2.2 The Beta Prototype (BP)

The BP is designed and manufactured using the AP as baseline. It was developed from March – September 2017. The production of a BP was not originally envisaged in the DoA of the project, but it was agreed by the consortium and has proven to be a valuable way of progressing the final design. For the sake of continuity, MicroPro employed the same prototyping company to produce the BP as produced the AP.

With the Beta Prototype MicroPro has aimed to achieve a leaner, cleaner, cooler design by

- Redesign of wooden housing for more streamlined shape.
- Redesign of aluminium chassis to make it more appealing, lighter, thinner and more robust.
- New sliding back cover, without screws or fasteners, for ease of access for removable battery and fingerprint sensor
- Material change of the seal-inlay into cork to reduce moisture and dust penetration
- Additional ventilation holes to maximise lifetime of battery and electronic parts
- Reduced number of parts.

The BP aimed at providing an improved template for design fabrication, leading to the production of the Kappa Prototype.

Fig. 2. The Beta Prototype

2.3 The Kappa Prototype (KP)

2.3.1 Objectives

The KP has been designed and manufactured using the BP as baseline. It has been developed over the period September 2017 to March 2018. The manufacture of the KP, being the 3rd iteration of the iameco D4R tablet, was not originally envisaged in the SustainablySMART DoA, but has proved a practical and effective method for arriving at the final design.

The AP and BP prototypes have been produced in a commercial production environment, but gradually adapting them for production in a small non-commercial fabrication environment. The commercially produced designs were then adapted by MicroPro and GMIT amending CAD drawings and specifications, to allow their implementation with the equipment available to GMIT. Alteration to the metal frame design was also required. The modified metal frame was manufactured initially in plastic through 3D printing, and then in recycled aluminium.

The KP incorporates all of MicroPro's eco-design principles of upgradability, updateability, durability, reusability, repairability, recyclability, ease of disassembly, longlife, carbon capture and elimination of most plastics. By using a wooden chassis instead plastic it not only incorporates carbon capture (carbon from our time) but allows us to modify and change the chassis. The KP is designed to anticipate future changes of components, so the chassis can be used again and again and have many different lives. It has also been designed so that the mainboard and ancillary components can be replaced or repaired using simple tools. The battery can be replaced in 30 seconds.

Use of glues or plastics other than those embedded in essential components have been successfully avoided. The housing is screwed together using 4 x standard Phillips type screws. Design ensures natural ventilation and prevents overheating. Connectivity is maximised. The wooden frame provides a protective standoff for the display and wood is natural, beautiful and carbon capture.

The KP is manufactured primarily from walnut, and has an interior recycled aluminum frame for robustness and stability. The KP is fully functional and manufactured to a state of the art electronics specification. Assembly of the electronics was carried out by MicroPro in-house. Re-design and manufacture of the KP was carried out by MicroPro and GMIT in the university's own engineering workshop, using CAD design and CCR manufacture, and has ensured that final drawings, specifications of housing and frame are fit for purpose.

Localised digital manufacture is the final stage in making the design and manufacture of the tablet commercially viable, and ensuring quality design and manufacture. The KP is the definitive model for the iameco D4R tablet and will provide a template for future commercial fabrication, although there is some scope for some modification before the end of the Project.

2.3.2 Review of existing CAD drawings of Alpha prototype

CAD files were provided by MicroPro for review. This review was carried out by the Principal Investigator in order to assess the ability to machine the prototype on the Homag CNC at GMIT campus.

- Design for Manufacture

Design for manufacture (DFM) is the practice of designing products with manufacturing in mind. This will allow for simpler manufacturing, assembly and/or design of the proposed product with the aim of reducing waste and minimising production costs. DFM principles are:

1. Minimise the total number of parts and sub-assemblies
2. Develop a modular design
3. Use standard components
4. Design parts to be multi-functional
5. Design parts for multi-use
6. Design parts for ease of fabrication
7. Avoid separate fasteners
8. Minimise assembly directions and methods
9. Maximise compliance
10. Minimise handling (machine time, multiple operations)

The correct implementation of DFM can lead to:

- Reduced manufacturing costs
- Reduced lead time
- Improved quality

DFM should also help to minimise waste and maximise yield from raw materials, which lowers production costs as timber waste from production is not recoverable for re-use. DFM is an important consideration when working under the Ecolabel logo which considers products from the extraction of the raw materials, to production, packaging and transport, right through to your use and end of life.

It is recognised that not all DFM principles are applicable to production of the iameco D4R tablet. Furthermore, this report focuses on key principles related to the manufacture of the wooden tablet case and not electronic or metal components. Finally, the following are examples of principles that guided the implemented design improvements from Beta to Kappa Prototype:

- Use Standard Components

Ensure that all fixings are standard and consistent where possible. Direction of pilot holes should be designed to ease machining but also post-assembly work.

- Design Parts for the Ease of Fabrication

The ease of production in products should require minimum amount of set up time in order to create or recreate a component. Jigs and holdings should be designed in a way to last the entire production process. It is advised that a less expensive material be used in set-up /

testing that has the same functional requirements in order to minimise potential waste and reduce cycle times.

Components should be prepared containing minimal waste, thus reducing processing time, unnecessary machining and waste material. Parts should also be designed for specific processes without the need for secondary processing. Hand-finishing or manual post-processing should also be kept to a minimum.

Understanding the machining capability is crucial to DFM. The design should facilitate maximising the use of automated processes which reduce processing time, minimise potential for error and maintain ultimate quality.

Using a single machine for production will obviously lead to significant savings in production times. An example of where multiple processes can be achieved is with the use of the CNC, (multiple heads and cutting tools).

The selection of a material that requires no pre-processing production work should be considered, e.g., can the raw material be ordered pre-sized or, if using veneers, can the materials be ordered pre-veneered (see section on materials below). However, caution is required here where the material cost could be higher than the in-house production cost of the same material.

- Minimise Handling

The term handling consists of the positioning and orientation of a part or component. In order to minimise the handling of a part it is advised that all parts or components should be symmetrical. This will allow parts to make every position easy to achieve, however if symmetrical cannot be used, then asymmetric should be exaggerated to avoid errors.

The principle also encourages the introduction of design handling and packaging friendly features to be considered and used in the designing of a product. The handling features include the use of flat surfaces, grooves and holes, which facilitate the orientation and placement of the product in production.

It is also recommended during the design process to take into consideration how the product is going to be packaged / shipped. This would help reduce excess waste material required to accommodate for the packing of the product.

- Design parts to be Multi-functional

This requires components within a product to have more than just one function and to combine functions wherever possible within the product.
The examples of where this can be achieved is the:

- Aesthetic and storage functions
- Work surface and structural functions

This can also be applied to manufacturing and assembly functions.

- Guiding/aligning
- Visibility
- Handling

Materials

This section deals with the selection of appropriate materials.
There are multiple options on timber-based materials for the product. These include:

- Solid wood
- Laminated wood
- Solid wood combined with veneers
- Composite material
- Plywood
- Biomaterials

There are also aesthetic, cost and in-service durability issues that need to be considered when choosing a suitable species of timber. Equally, there may be certain advantages that can be achieved by using veneers with a suitable substrate.

The Beta and Kappa prototypes were made of solid wood :

- Use a species with closed grain (e.g. maple or beech)
- Use timber with straight grain, free of knots and defects
- Grain direction should be perpendicular to surface to minimise movement (radially cut)
- Reduce moisture content to maximum 10% (to minimise distortion in service)
- To deduce tendency of cupping in service, it may be worth using glued strips of solid wood.

It will also be important to use ethical procurement when specifying timber materials. It is assumed that timber from certified sustainably managed forests would only be used. Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC) schemes are those most recognised for ensuring chain of custody of sustainably sourced forest material. We can also use off-cuts from the furniture industry and second life woods.

An example of a material that might be considered that meets the needs of both the material and DFM is Pollmeier's BauBuche beech laminate (www.pollmeier.com/en/products/baubuche/baubuche-about.html) – this is just an example of engineered / laminated boards that are available.

MicroPro decided to use **walnut** as the material for the Kappa as it has a deep lustre and warm and attractive grain.

2.3.3 Review design of Beta Prototype

This review was carried out with respect to making the Beta suitable for manufacture on CNC machine and other automated equipment at GMIT, considering improvements to aesthetics and minimizing post-production finishing requirements. It was important to retain the overall aesthetic of the Beta prototype when considering any redesign proposals, see image below (Figure 1). To get a better understanding of the processes involved in the manufacturing of the Beta prototype, an exact copy of the Beta was produced, to highlight the areas of inefficiency. The following is a list of processes that were identified from this study, along with observations from the original Beta prototype.

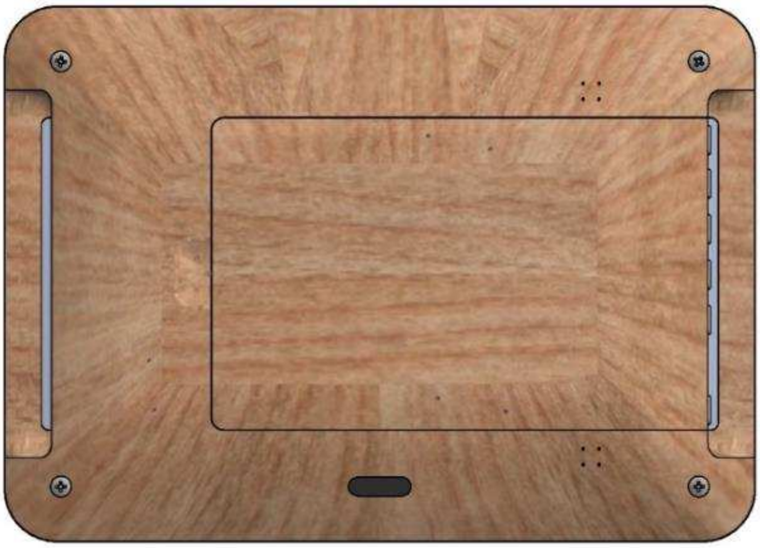


Fig. 3. Beta image

- Areas identified for redesign - Exterior

The exterior areas of the beta prototype that were identified for redesign are as follows:

- The parts highlighted in red below (Figure 2) are difficult to reach when it comes to the sanding stage, due to the concave form and approximately doubles the time it takes to sand the exterior.
- The sections highlighted in green are largely short grain and therefore are not structurally sound.
- The metal housing of the buttons and ports were fastened with glue and required a redesign to eliminate the need for adhesives (Figure 4).
- The battery lid was catching on the battery, as there was not enough clearance for safe removal.
- The various ports such as HDMI/DC seen in the right-hand image below, were not correctly aligned and consequently were not functioning properly.

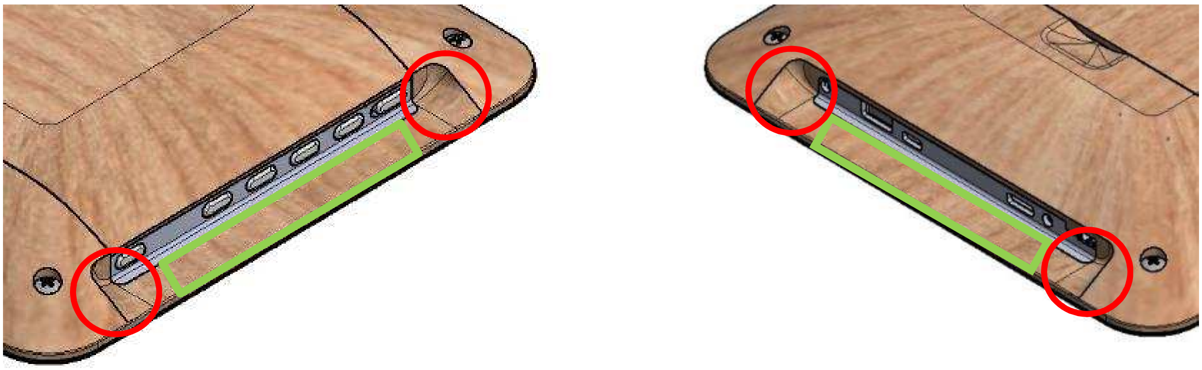


Fig. 4. Beta Tablet Exterior

- Areas identified for redesign – Interior

- The internal section (Figure 5) of the Beta tablet consists of numerous pockets with varying levels, which significantly increases the manufacturing time.
- The opening for the battery was not correctly aligned from a plan view and required adjusting.
- The lens was fastened with glue and required a redesign to eliminate the need for adhesives.
- Additional allowance for cabling was advised for the Kappa following review of the internal section, see section highlighted in red.
- The section highlighted in green was identified as inadequate as it is largely short grain therefore not structurally sound.

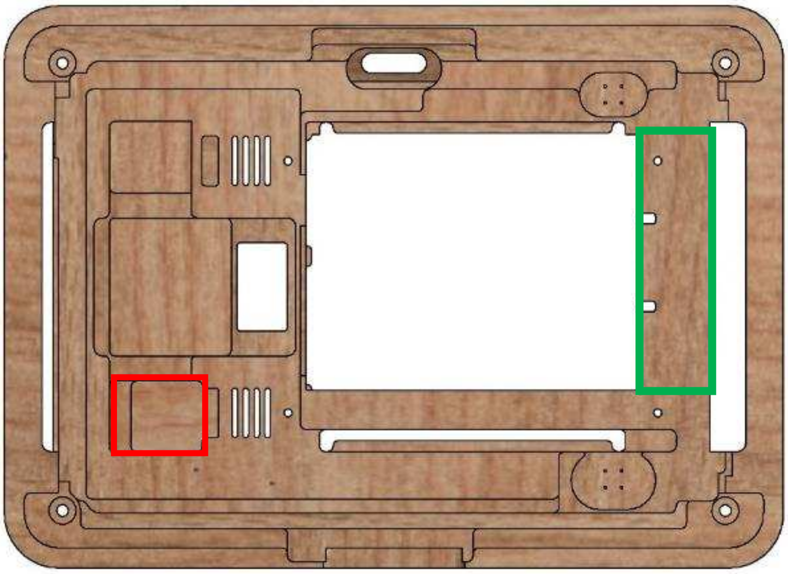


Fig. 5. Beta Tablet Interior Section

- Areas identified for redesign - Beta battery cover
    - Part of the battery cover is difficult to sand when it comes to post-processing stage, due to its steep nature and being mostly end grain, which increases the manufacturing time (Figure 6).

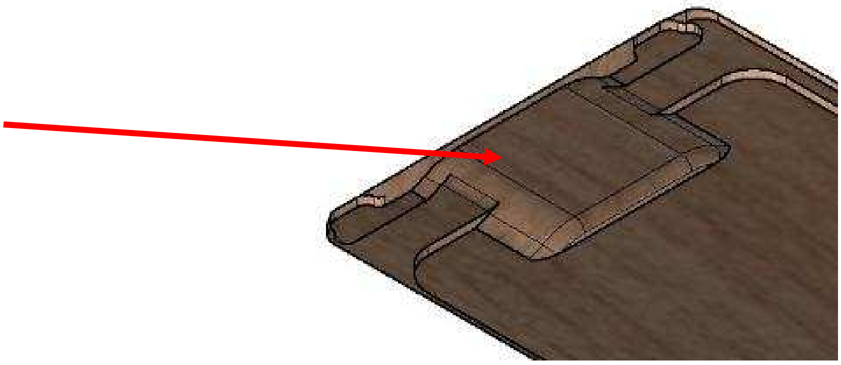


Fig. 6. Battery cover

2.3.4 Kappa Prototype Redesign

Having reflected upon the issues observed in the Beta Prototype a Kappa Prototype design was then developed.

Kappa Tablet – Exterior

The following is a list of the design improvements within the Kappa following this review.

- The areas highlighted by the letter (A) in (Figure 7) now have a convex form, meaning the overall exterior can be sanded via power tools. This iteration reduced the sanding time from 95 mins to 45 mins approx., i.e. depending on unique grain pattern / minor defects within the wood.
- The sections highlighted by the letter (B) in (Figure 7) are now combined with the front metal frame chassis, alleviating the short grain sections within the Tablet and the use of adhesive.
- The overall thickness of the wooden chassis was increased to enable the battery lid to move freely over the battery.
- The various ports such as HDMI/DC seen in the right-hand image below (Figure 7) were realigned, along with removing some additional material to enable the cables to function correctly.

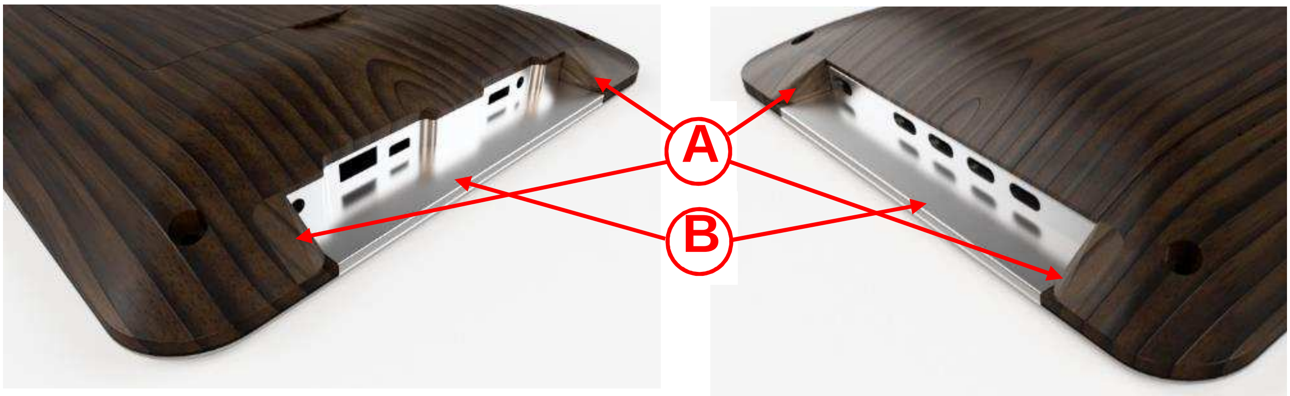


Fig. 7. Kappa exterior section

Kappa Tablet - Interior

The main objective with the internal section was to try to reduce the machining time, so that the manufacturing process becomes more viable, whilst maintain an adherence to quality at all times. With CNC machining, when the cutting tool meets a corner it must stop. Therefore, the speed at which it is traveling must slow down and come to a halt and likewise the tool requires additional time to meet full capacity when beginning a new cut. To increase the speed at which the internal section of the wooden chassis is processed, the following iterations were made to the Kappa design:

- The areas highlighted in red in the left image (Figure 8), indicate material that has been removed following the Beta review and the image on the right (Figure 8) shows additional material highlighted in green. The reasons for adding and removing material was for realignment of components, clearance for parts which were under strain in the Beta, strength and levelling the number of steps / pockets within the chassis.
- The number of pockets has been significantly reduced, to enable the cutting tool to move more freely.
- The Beta version had numerous radii, as small as 1mm, which meant that the machining required numerous tool changes. By making the smallest radius 2.5 mm within the internal section of the wooden chassis, it removes one tool change from the machining process.
- The four corners within the Beta version restricted the cutting tool when it came to roughing out the bulk of material via the CNC. By enlarging the radii and creating a more gradual transition within the form of the chassis, it enables the cutting tool to move more freely.

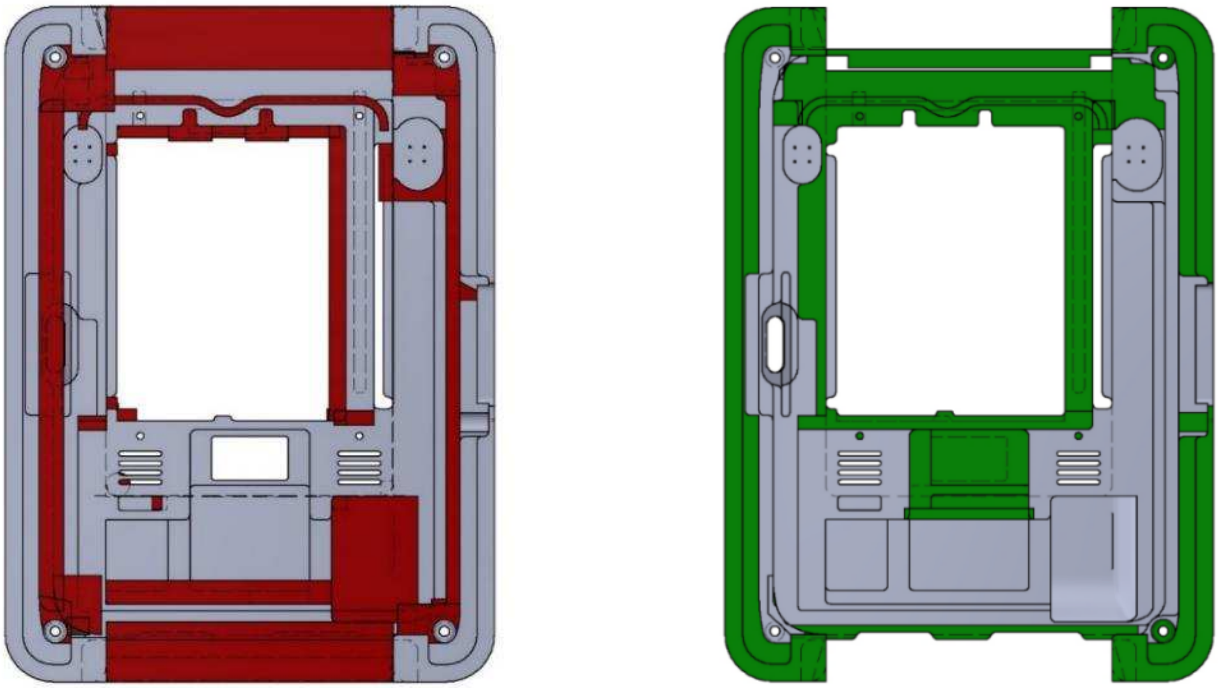


Fig. 8. Kappa interior section (schematic layout)

As highlighted in the Beta review, design modifications have now been addressed as outlined below.

- As emphasised previously, the section marked (A) (Figure 9) is largely short grain and required a redesign. The Kappa design, has a reinforcement metal plate, with additional metal plate on top, which acts as a washer. This enables the main plate underneath, to have larger holes where the screws meet, allowing the wooden chassis to expand and contract as necessary.
- The opening for the battery was addressed and is now correctly aligned.
- Additional allowance for cabling was also addressed.
- Cable tidies were added to the chassis to hold cables in place. (B) (Figure 9)
- The lens fixing was redesigned and is now attached with the addition of a metal plate. However, this is still not the final solution and requires further iterations. (C) (Figure 9)

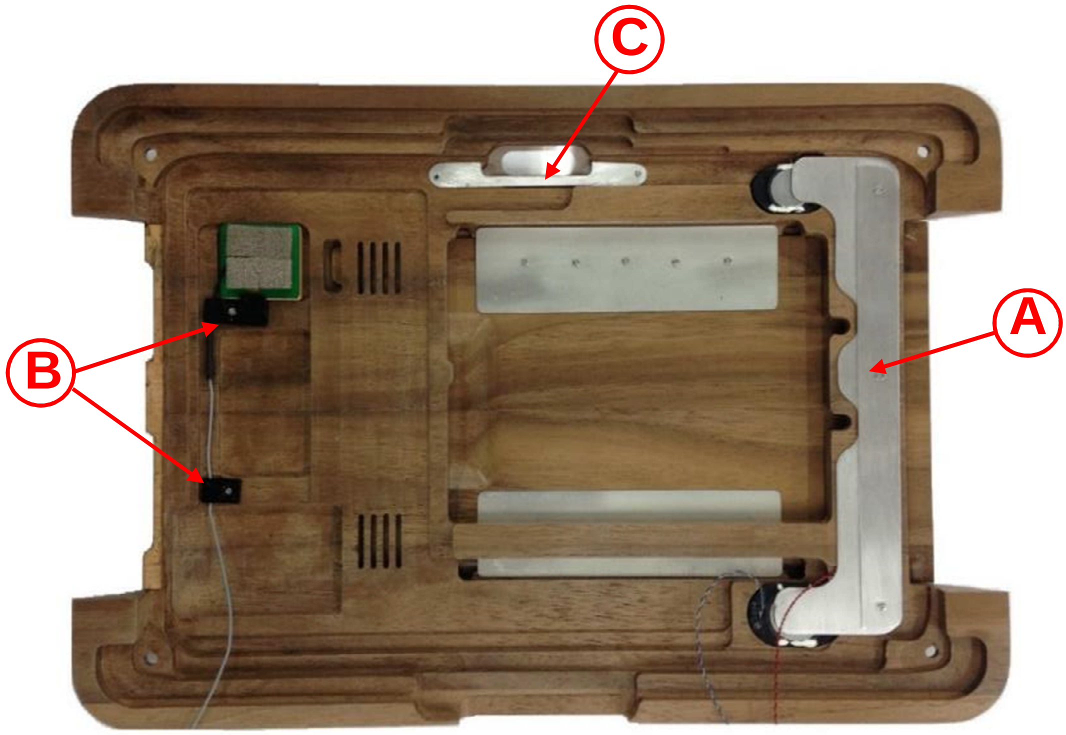
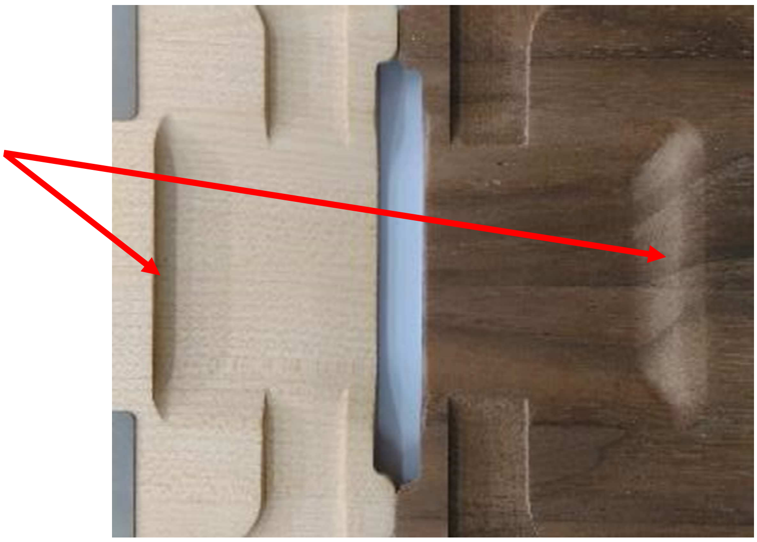


Fig. 9. Kappa interior section and comparison with Beta details

- Internal section of the Beta battery cover

- The area highlighted in the Beta review on the inside of the battery cover has now a more gradual slope. This reduces the time it takes to finish the internal section of the battery cover, (Figure 10).



Beta Kappa

Fig. 10. Kappa & Beta interior battery cover

- Process Diagram of the Kappa

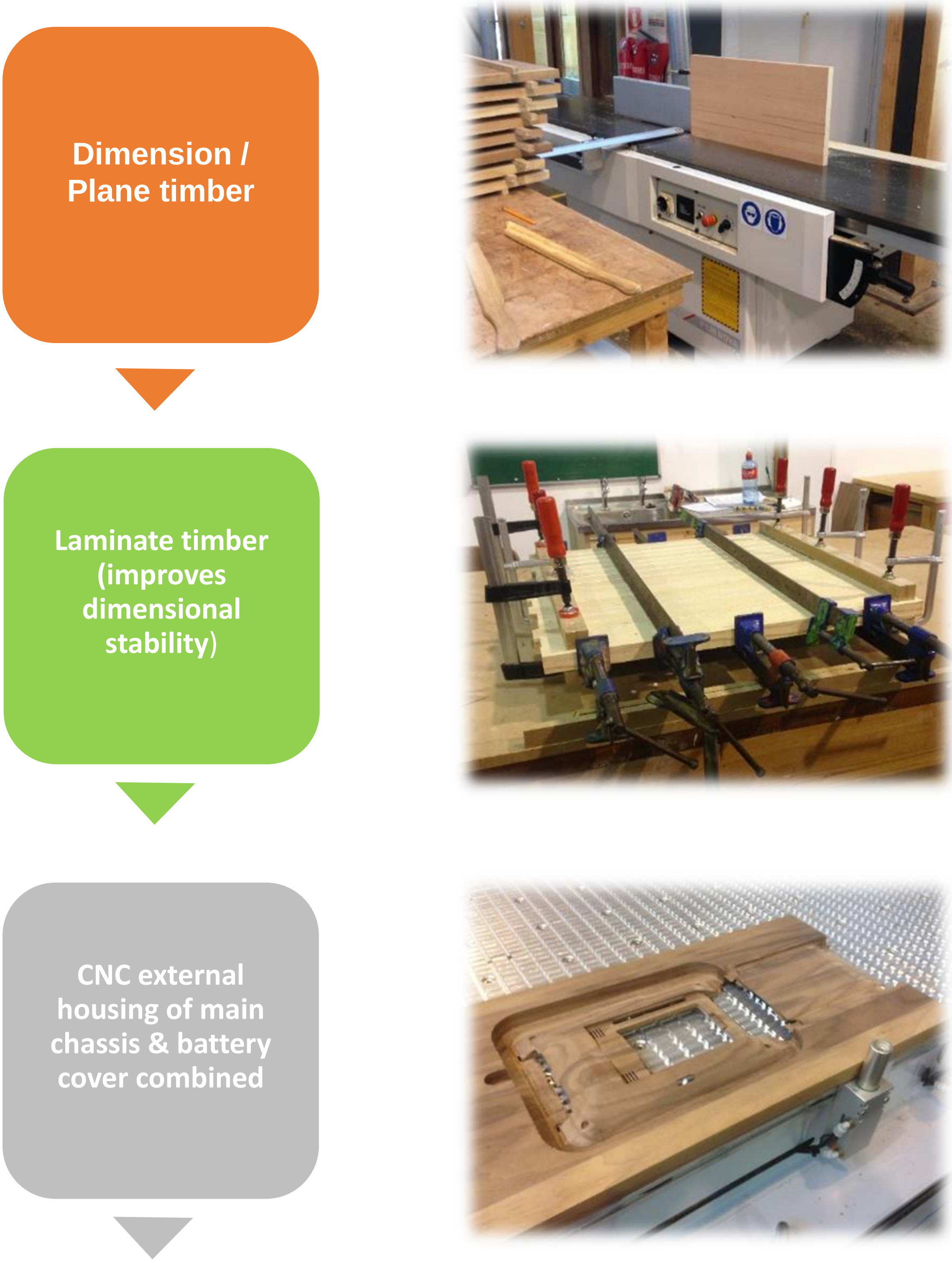


Fig. 11. Process Diagram (Part 1)

Fig. 12. Process Diagram (Part 2)

- Finishes

As the deliverables altered over the course of the project the time for exploration of finishes was limited. However, two potential finishes were considered, a water-borne lacquer and an orange oil for its eco qualities. However, due to time constraints it was decided to use the lacquered option as it was considered more durable and was the fastest option for batch production. The time required to finish the tablet with two coats of water-borne lacquer was 25 minutes, this includes cutting back the first coat.

2.3.5 Further consideration and research

This section outlines some further issues pertaining to the further development of the product and some areas that were outside the scope of research carried out by GMIT.

Originally the Beta prototype took a total of 163 minutes approx. to machine on the CNC, with the iterations to the Kappa design this has been reduced to a total of 118 minutes. The sanding of the Beta was estimated to be 180 minutes due to the difficult areas to reach. The redesigned elements of the Kappa, reduce the sanding process to 90 mins approx., depending upon individual grain pattern and species selection. The lamination process that created the blank was done by manual clamping and therefore does not provide an accurate estimate on the time it requires to produce in batched or higher quantity production runs. However, the time it took to dimension, plane, and finally calibrate the blank manually was about 75 minutes per blank.

This is a total of 283 minutes for creating the Kappa's unfinished wooden chassis (based on a production of 1 single unit). This brings the total time of wooden chassis in its current form to 308 minutes with a water-borne lacquer finish. It is expected that this would be further improved and reduced as production volume increases.

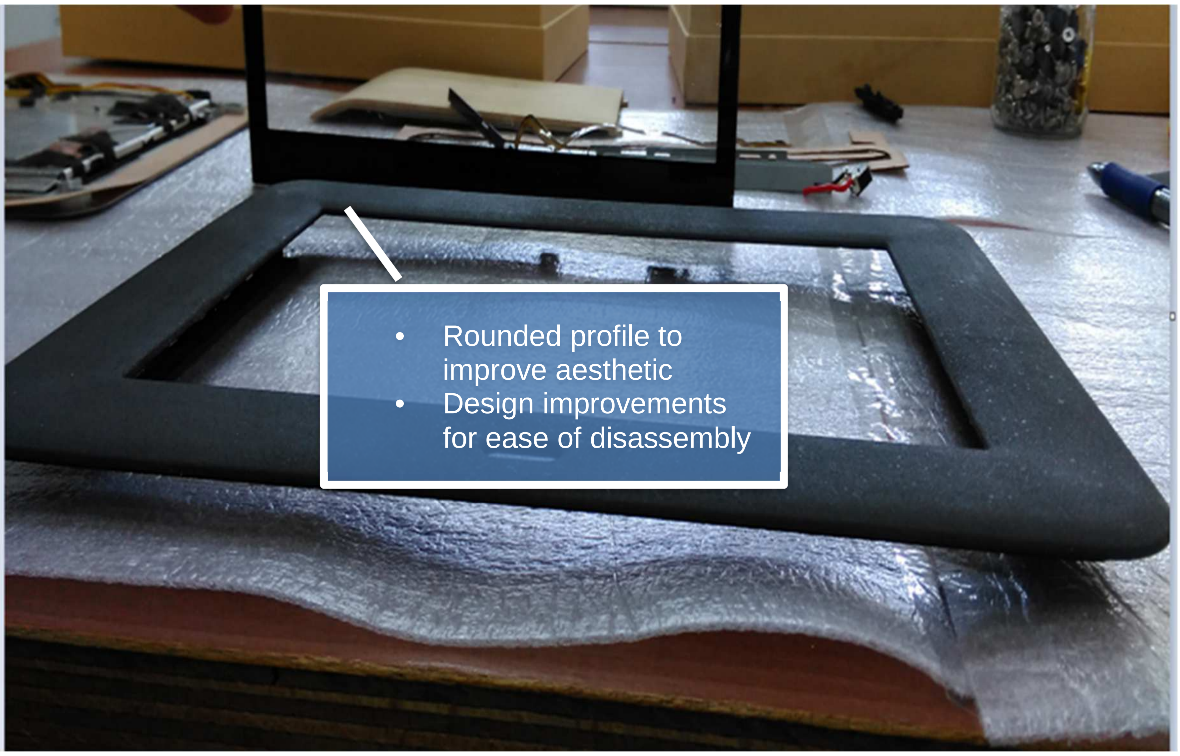
Moisture content of timber will be an important consideration in order to minimize movement of the wooden housing in service. Prior to machining the Kappa, the timber was climatized over the course of four weeks (Figure 13). Initial moisture content of the walnut was 9.4% and at the time of machining this was brought down to 8.3%. Preparation and storage of raw materials and finished product would need to be considered prior to full production beginning and would require further exploration and testing to establish optimum conditions.

Fig. 13. Climatizing timber prior to machining

2.3.6 Metal Frame design improvements

The design of the KP also required a re-design of the metal frame underpinning the housing.

A number of key design improvements were carried out to the frame in relation to the BP. These improvements are depicted in Figure 14.



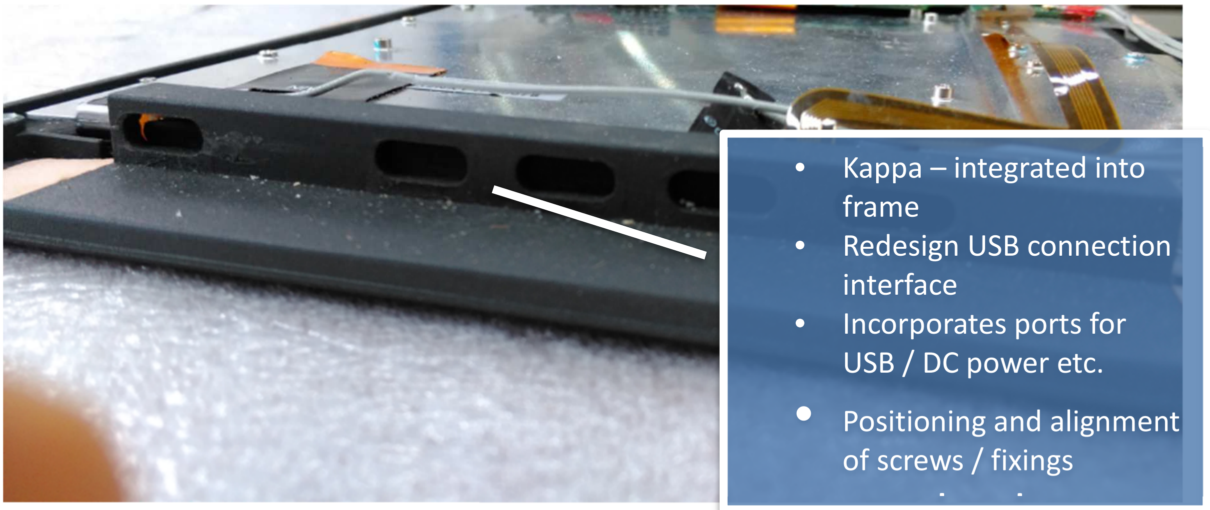


Fig. 14. Metal frame improvements

2.3.7 Electronic specification improvements

The redesign of the KP also improved on the BP with respect to the electronics specification. The main improvements were as follows:

- Intel Quad Core 1.83GHz, 10.1” with 4G/128G
- WiFi - 802.11B/G/N/AC wireless 2.4G/5GHZ
- 1*MicroUSB, 1*USB2, 1*TF CardSlot, 1*HDMI, 1*Earphone jack,1*SimCardSlot
- Built in 4.0 Camera: front 2.0 MP, rear 5.0 MP
- Modular GPS and Kill switch - optional
- Modular fingerprint sensor - optional
- Docking Station, Additional Battery, Handheld Belt
- Software: Android or Microsoft

3. Next steps: Testing of the KP

Verification of the technical performance of the Kappa Prototype will be done by test measurements usually required for CE compliance.

This will be carried out over the following 6 months of the project.
Grant4Com will contribute input on the regulatory requirements of the KP and other standards that will have to be met before it can potentially go into production and market, including:

- EMC Testing according to:
  - EN 301 489-1 V2.1.1 (General) + Draft EN 301 489-17 V3.2.0 (BT WLAN) + Draft EN 301 489-52 V1.1.0 (Cellular)

These include emissions, immunity and ESD testing

- RF testing for:
  - 3G according to EN 301 908-2
  - Bluetooth according to EN 300 328 V2.1.1
  - Wi-Fi 802.11b/g/n according to EN 300 328 V2.1.1
  - Wi-Fi 802.11a/ac/n according to Draft EN 301 893 V2.0.7

- SAR testing for portable device according to EN 50566

- Safety testing according to EN 60950-1:2006 + A11:2009 + A12:2011 + A1:2010 + AC: 2011 + A2:201

- Battery is in compliance with IEC 62133

Testing for RoHS Directive 2011/65/UE compliance.

There are strict limits for passing these tests to prove compliance with the regulation.

Other partners will contribute other feedback and input as follows:

- iFixit – assessment and report with respect to ease of dissassembly and reparability
- AT&S – assessment and report with respect to thermal management and heat distribution in the KP,
- Fraunhofer IZM – life-cycle assessment of the environmental impact of the KP.

These reports, when available, will be added as appendixes to this deliverable.