4-6-2015

COMPAC SORTING EQUIPMENT

TIP TOP TIPPING

Graduation report | Joris Splinter

Preface

This report is written on my graduation assignment at Compac sorting equipment. The project is my final project for The Hague University of Applied science back home in Holland. At The same time it is a relevant project at Compac sorting equipment in New Zealand.

It was a unique experience, graduating in NZ. Something I have really been looking forward to, and it turned out to be even better than I could have possibly expected. I love the countryside here in New Zealand. The scene is absolutely beautiful, especially compared to The Netherlands, where everything is flat and asphalted.

Besides the lovely country, I am also very pleased to work at Compac. I found a lot of positive aspects here, that I have not been able to find in any company in the Netherlands yet. The hands on approach, the opportunity to build prototypes, the nice workmates… everything I`m looking for in my job as an engineer, but couldn't find in any of my previous internships.

This report is written for people that might proceed with the project after my time at Compac has come to an end. It will give a good picture on how the final solenoid is developed and why certain decisions are made. The report is written for The Hague University as well. For university, it will be my graduation report. Off course, it is intended for all other people that are interested in my graduation project in New Zealand as well.

I would like to thank Tim Jenkin, for being my internal mentor here at Compac. It was a pleasure working with Tim and it helped me great to have someone to talk to about the project. Big thanks to Sheldon White as well, for being very involved in the project and being very helpful with troubleshooting when testing different prototypes. Lastly, I would like to thank Jaap Mijnster, my university mentor, for the university related support.

Auckland, June 2015

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Summary

This report describes the research and development of the design of a new solenoid solution that can tip fruit two ways on the K-carrier machine. Chapter one gives some background information on the company and the assignment. It gives an explanation of the machine its operation with different pictures.

Chapter 2, Describes the approach and planning that is followed during this project. It tells a lot about the followed method to get to the final result. Using the "Kesselring" selection method, a final concept is selected and designed further.

Chapter 3, Will tell about the final results that are achieved during this project and how the final design performed during the in-house tests. The last stage of the project, the site trial, could not be described completely because it will be completed after this report is finished and handed in.

Conclusion is that there are multiple solutions to tip fruit dual side on the K-carrier machine. By testing each solution against functional and manufacture criteria, the ideal solution can be selected.

Explanation of terms

K-carrier	Machine designed for handling large fruit like mango`s. It is the newest, largest model in the carrier range, following the alphabet after the H-carrier.
Carrier	A carrier is the plastic assembly with soft rubber rollers and is able to carry one piece of fruit. It can be tipped sideways to let fruit fall off the machine at the right moment.
Solenoid	Solenoid can refer to two things: it is the complete product that tips the carriers when activated, and it can be the electrical component that is moving the mechanism when powered. Depending on the context, one of the two meanings is meant.
I/O	Input/Output. This refers to the electrical switches that are controlled by the sizer computer.
Sizer computer	Computer which contains the software for fruit sorting. This computer decides when and where certain fruit is tipped

1 Introduction

1.1 Company description

Compac sorting equipment is an international operating company. The company designs, fabricates, assembles and installs many different kinds of fruit / vegetable sorting machinery.

Starting in a garage in NZ with kiwifruit, Compac has vastly grown to become marked leader in the U.S. and is now selling machines all over the world. The company is now growing faster than ever, and has plans to become the market leader in Europe too.

The approach in the R&D department and development centre is very hands-on. New ideas are generally quickly tested, instead of having a lot of discussion about it beforehand. This approach gives the designer a better opportunity to make the right decisions based on test results and optimize to a well working final design. That being said, there is still a lot of structure in the projects. Between every next step, a detailed testing phase is required to make sure the final product will work as good and as long as possible.

1.2 background information

The K-Carrier fruit sorter is a machine that is designed for large fruit like mango`s. To tip the fruit on this machine, a temporary solenoid solution is designed to proof the overall machine. (See fig. 1.1 on the next page) It works, but doesn`t have all the functionality Compac is looking for, and it needs a relatively expensive heavy duty solenoid that Compac wants to get rid of. For this reason a new solenoid needs to be designed that can fulfil all the required functions, and will hopefully lead to a significant cost reduction. Fig. 1.2 shows the K-carrier tipped.

Fig. 1.1 K-carrier with current solenoid

Fig. 1.2 K-carrier being tipped

2 Method

2.1 Project assignment

The project assignment is to design and test a new dual side tipping solenoid for the K-carrier machine. Different concepts need to be designed, build and tested in the development centre. After different test results can be compared, a final solution will be selected and then a final design can be made.

2.1.1 Problem & Goal

The main problem statement of the project is:

- How can we tip fruit both ways on the K-Carrier and optimize the tipping?

Sub problems are:

- Using a smaller/cheaper solenoid as the current design.
- With minimized costs of produced parts
- Proof of concept / prototypes manufacturable in development centre.

There are two goals:

1. The goal of the project is to develop a new solenoid design that is able to tip the fruit on the K-Carrier duel side. A 3D cad model of this design is required.

2. The second goal is to test the new design and optimize the tipping of the carriers. Therefore, a proof of concept / prototype is required for testing and optimization.

2.1.2 Assignment description

The assignment can be divided into the following parts:

- Design, build and test different concepts of duel side tipping solenoids for the K-Carrier
- Selecting a final design working together with senior engineers
- Releasing a non-tooled version for testing in the test centre
- Make a final (tooled) design optimized for low cost production

2.1.3 Requirements

Fixed requirements

- Solenoid has to run on 24V drawing less than 1 Amp
- Duel side tipping solenoid has to be able to tip the fruit both ways
- Light fruit (160g) should be tipped consistent at a relatively high machine speed of 450 carriers/min
- Heavy fruit (up to 1.7 kg) has to be tipped consistent at the machine design speed of 350 carriers/min
- Tipping consistency of at least 99.9%
- Solenoid geometry has to be flush with the aluminium extrusion profile it is mounted on.
- Solenoid spacing can be 600 mm (carriers must be fully tipped within this distance)

Measures of success

- use a smaller (cheaper) solenoid to drive the duel side mechanism compared to the current solenoid
- use as little as possible IO`s, every IO can handle .5 Amp at 24 Volt
- Design as cheap as possible to manufacture / assemble
- Mechanism able to tip the fruit as gentle as possible, to prevent any fruit damage
- Mechanism can work well on an as large as possible solenoid timing range. (Amount of pulses offset from optimized timing)

2.1.4 Project scope

Because there is a limited time available for this graduation project, it is important to scope the project. This paragraph will define the project tasks and deliverables that are in the project scope, and the tasks that need to be done after the project is finished.

In scope deliverables:

- Different concepts + proof of concepts
- 3D CAD Design of the selected concept
- 1st release of the duel side tipping prototype
- if needed, 2nd release of the duel side tipping prototype
- CAD redesign for larger series production and cost reduction
- Final prototype ready for larger scale production
- Project report

Out of project scope:

- 1st series using larger series production methods

2.1.5 Approach & planning

In the following chapters, the activities described in this planning will be described further. Please see chapter 3 to read about the final results following this planning.

Week 1
- Getting familiar with K-carrier machine and current tipping solenoid solution
- Analysing duel side tipping solenoid used for H-carrier
- Building and testing first idea`s for duel side tipping K-carrier

Week 2
- Concepting new idea in SolidWorks
- Determining dimension of mechanism in SW using sketches
- Prepare in-house production in development centre

Week 3
- Building heavy duty proof of concept for new tipping mechanism
- Getting mechanism to work on original solenoid
- Automating the tipping using a light sensor + Arduino. Both are available for this purpose.
- Running durability tests to see if mechanism works consistent
- Decide with senior engineers if concepts will be developed further to prototype stage

Week 4
- Detailed testing proof of concept on higher speeds tipping light fruit
- Video analyses with a high frame rate
- Analysing results
- Start designing lighter prototype version made of sheet metal
- Keep running tests with proof of concept

Week 5
- Finish duel side tipping design and create technical drawings for production.
- Creating all DXF files and drawings in LN and checking in for ordering

Week 6
- Production of all sheet metal parts at specialized supplier

Week 7
- Assembling prototype parts, and mount prototype on K-carrier machine
- Getting familiar with sizer software, linking prototype to computer and use the sizer to trigger it
- Running detailed tests with prototype and duel side tipping

Week 8
- Optimize the duel side tipping, testing with different trigger shapes.

Week 9
- Updating project requirements to meet new requirement: solenoid needs to be flush with aluminium extrusion profile
- Running more tests with prototype and optimize duel side tipping.

Week 10
- Making new concepts that can meet the new requirement to be flush with aluminium extrusion profile

Week 11
- Making proof of concept of new mechanism modifying the current prototype
- Test if new mechanism works well on the K-carrier machine

Week 12
- Comparing all concepts and prototype results and check against selection criteria
- Working with senior engineers and test centre supervisor, selecting a final concept.
- Start making final design in SW
- Order new prototype part for final design prototype

Week 13
- Assemble new prototype and make ready for demonstration in test centre
- Meeting with senior engineers and technical managers to decide about the possibilities of final design and if design can get ready for production when further tested
- Start working on project report for decent documentation

Week 14 - 15
- Working on project report
- Testing and optimizing final version

Week 16
- Hand in first version of project report and have it checked by company coach.

Week 17
- Finish and hand in project report

Week 18 – 19
- Project is finished for graduation at university, last 4 weeks are available to get final design ready for production

2.2 Concepting

After the functioning of the K-carrier machine is analysed, different concepts can be generated that can tip the carriers. Because the in-house production methods are easy accessible, most concepts can be tested as a proof of concept on the K-carrier machine. This method of real life testing makes it easier to choose the best final concept and make sure the best final design is achieved. This chapter will describe the different concepts and their pros and cons.

2.2.1 Concept 1: "Side tipping"

Concept description
This concept is based on the H-carrier dual side tipping solenoid and tries to make the same principle work for the K-carrier machine. The concept uses a trigger that moves around one pivot point, and is moved by activating an electromagnet. The electromagnet pushes away the permanent magnet when activated. This will result in a trigger motion around the pivot point, which can almost be described as a horizontal motion, considering the part of the pivot circle it moves along. Fig. 2.1 shows a sketch of the concept and its trigger motion

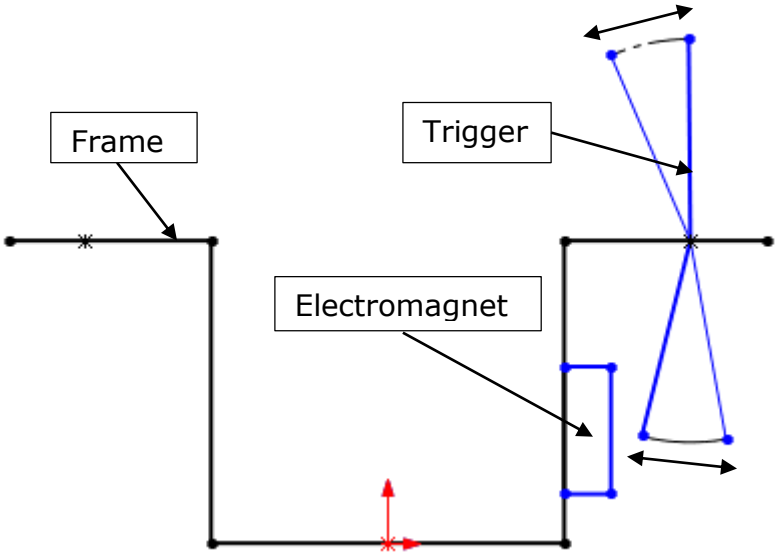


Fig. 2.1 side tipping concept

Pros:
- Simple mechanism
- Not many parts
- Cheap to manufacture
- Already works on H-carrier

Cons:
- Can`t use a large trigger,
- Carriers might hit opposite trigger to hard when tipped
- Not much space for dual side tipping

2.2.2 Concept 2: "Sliding trigger"

Concept description
This concept has been created to investigate the possibilities of an alternative trigger motion. Instead of using a pivot point, it lets the trigger slide in a slot to create an upwards and sideways motion at the same time. This should give more space for the carriers to be tipped dual side without hitting the other trigger. Fig. 2.2 shows a sketch of the concept and the alternative trigger motion

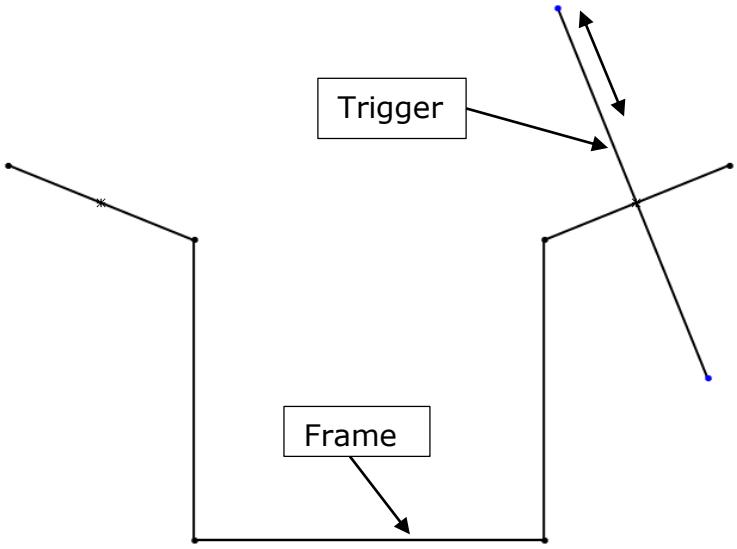


Fig. 2.2 sliding trigger concept

Pros:
- More space for the carriers to be tipped
- Not a lot of parts
- Good opportunity to investigate alternative trigger motion

Cons:
- Much wear in sliding parts
- Much force required to hold trigger up

2.2.3 Concept 3: “triple pivot point mechanism”

Concept description
This concept starts with the idea that we want an upwards motion as well as a sideways motion to create more space for tipping the carriers. In this case, a new pivot point is used to acquire this. To move the trigger around this pivot point, a mechanism is used as shown in Fig. 2.3. When the trigger is moved up, the two hinges are collinear. This position will lead all forces, caused by tipping heavy fruit, directly into the frame. Therefore, a smaller and cheaper solenoid can be used to tip heavy fruit.

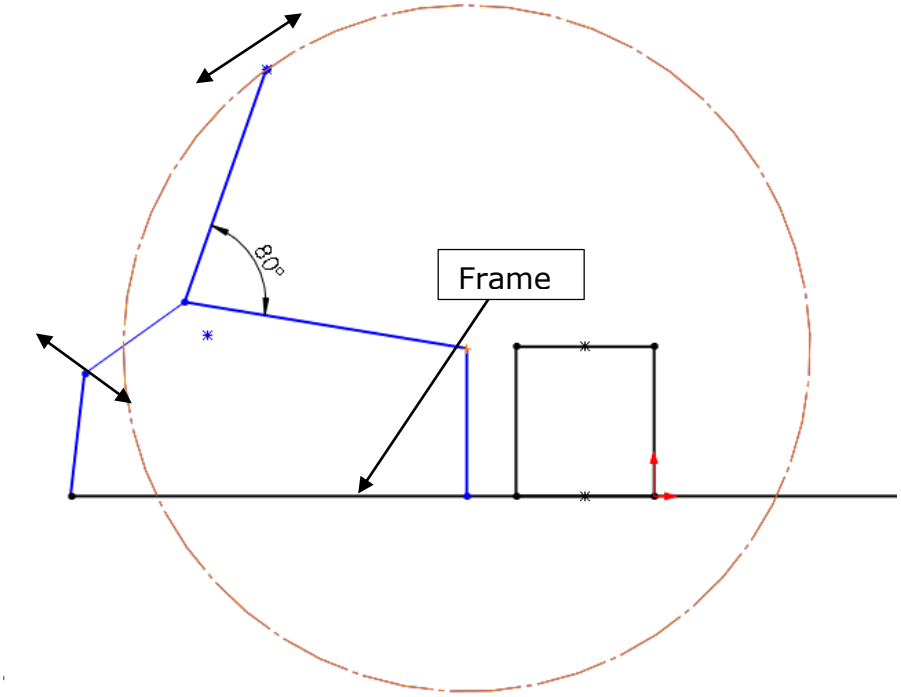


Fig. 2.3 triple pivot point mechanism

Pros:
- New trigger movement, more space for tipping dual side
- Small, standard solenoid can be used
- All moving parts are pivot points, wear resistant

Cons:
- More parts required to move trigger compared to current solution
- Might be difficult to manufacture on larger scale
- Solenoid not flush with extrusion profile (new requirement after concept was created)

2.2.4 Concept 4: “Cam mechanism”

This concept is a next version of concept 3. It uses the same pivot point for the trigger movement, but with another mechanism, to make it possible to mount the solenoid flush with the extrusion profile. The solenoid will pull a cam, which will slide against the trigger plate and create the rotation. Fig.2.4 shows the sketch of the cam mechanism concept. This figure is orientated 90deg from previous sketches.

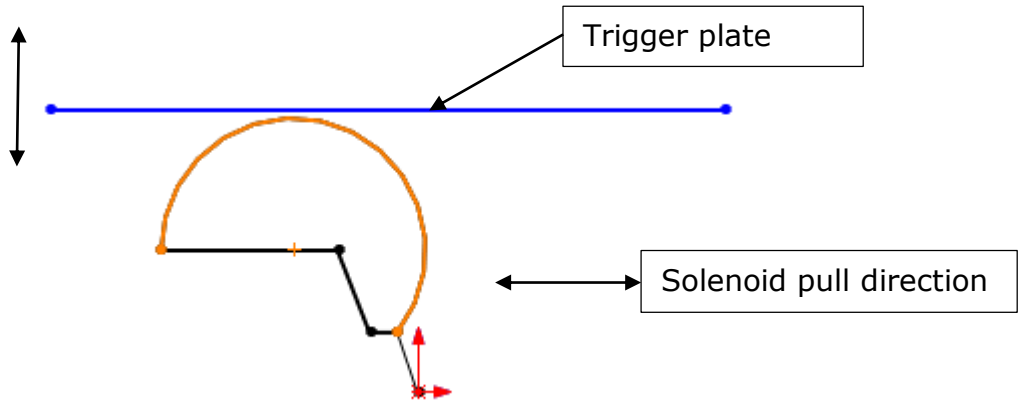


Fig. 2.4 Cam mechanism concept

Pros:

- New trigger movement, more space for carriers to tip
- Solenoid flush with aluminium profile

Cons:

- Too much wear in cam/plate is expected

2.3 Prototyping & testing

In order to choose the best concept for making a final design, it is very helpful to make proof of concepts / prototypes for all the different concepts. This stage will teach us a lot about the manufacturability of the designs, and also gives the opportunity test each concept real life on the machine and analyse its operation with a high speed camera. All proof of concepts can be manufactured in-house using the materials and tools in development centre. If a next version is needed, and more accurate production methods like laser cutting are required, parts can be ordered at specialized suppliers.

2.3.1 Proof of concept 1

Proof of concept
From this concept, a first proof of concept was available when the project started. A frame with two triggers where already finished to be tested on K-carrier machine. (See fig. 2.5) This proof of concept is very similar as the H-carrier dual side tipping solenoid. Difference is it has two very long triggers to tip the K-carrier smooth. Note that the triggers shown in fig. 2.5 are shortened to a minimized size, to make the prototype able to dual side tip the carriers.

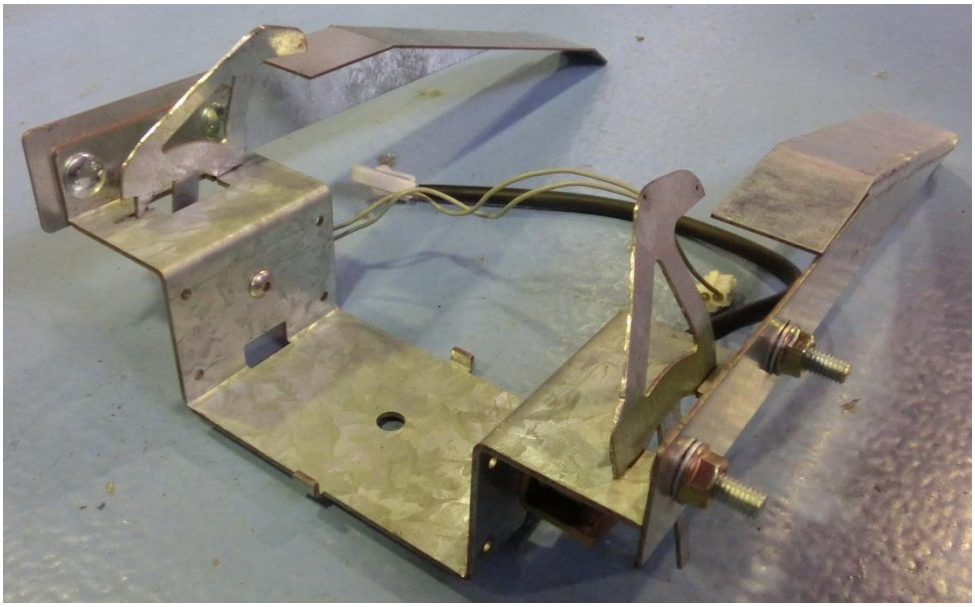


Fig. 2.5 Concept 1 proof of concept

Test result
The very first test on the K-carrier machine did not show any good results. Assumed was that to tip the K-carriers smoothly, a relatively long trigger was needed. Therefore the proof of concept was equipped with long triggers for testing. Using such triggers, this concept was not able to tip the carriers both ways, because there was not enough space for the carriers to tip over without hitting the opposite trigger. Sometimes the carriers even bounce back and fell over to the other side. In a later stage of the project, smaller

triggers where used on the same proof of concept. Using this small triggers, the proof of concept suddenly gave very promising test results. To read how and why the short triggers where discovered, please see "design notebook" in appendix I. To summarise multiple tests and high speed camera video`s: the proof of concept worked fast, consistent and tipped both heavy and light fruit very smooth.

2.3.2 Proof of concept 2

Proof of concept
To investigate and test if it is possible to make a longer trigger work on a dual side tipping solenoid, a proof of concept is made for further testing on the machine. This proof of concept is equipped with a relatively long trigger that is able to move vertical and horizontal at the same time, while sliding in a slot. Purpose of the proof of concept is to find out how it will tip the carriers and if more space is gained for tipping the carriers dual side. Fig. 2.6 shows a picture of proof of concept 2 when mounted on the K-carrier machine.

Fig. 2.6 proof of concept 2

Test result
For the purpose this proof of concept is made for, the test results are very promising. It tips the carriers very easy and the non-activated trigger position gives a lot more space for the carrier to fall over without hitting the trigger. The main purpose of this proof of concept was to learn about this new trigger motion, without paying attention to make it a long term solution. After some tests where done, a lot of wear in the trigger material was already showing up. Therefore, this concept will not be one of the options in the final concept selection.

2.3.3 Proof of concept 3

Proof of concept
To make this proof of concept work on the K-carrier machine, it is important to determine the exact geometry that will result in the required trigger movement. To do so, the geometry is determined in SolidWorks using sketch mode. Once we know the geometry, a proof of concept can be made as shown in fig. 2.7. This proof of concept is manufactured in the development centre. It uses relatively heavy materials to make it easy for welding and manufacturing using the in-house production methods. The proof of concept is temporarily driven by the original heavy duty solenoid, because the parts are made this heavy. When a lighter version is manufactured, the concept might work with a lighter and cheap solenoid.

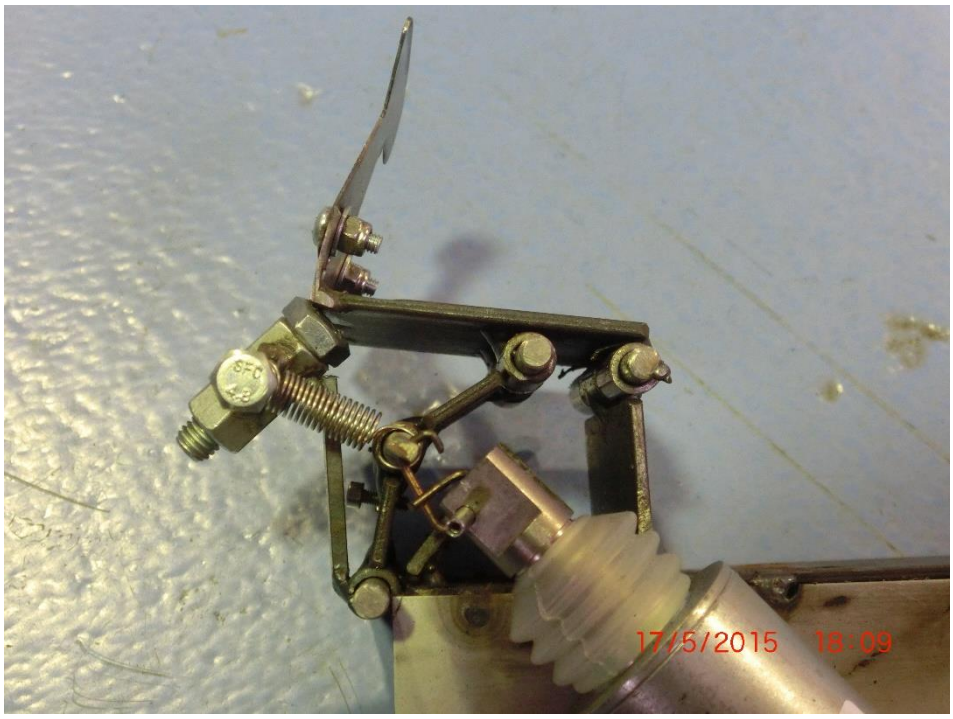


Fig. 2.7 proof of concept 3

Test result
The first test results of this proof of concept looked very promising. The geometry was spot-on and created a lot of space for the carriers to tip. Because the proof of concept had such good results, a next version has been designed made out of lighter sheet metal and with two triggers for dual side tipping. This design is laser cut and bended by a specialized supplier and assembled in-house for further testing.

Prototype

The prototype version of concept 3 uses the same geometry and mechanism as its proof of concept, but is made out of lighter sheet metal and works on both sides to see if it can dual side tip. A picture of the assembled prototype is shown in fig. 2.8. For this prototype, more accurate production methods were required. Therefore, 2D drawings are made for production at a specialized supplier. See appendix II: ”Drawings concept 3” for detailed drawings made for production.

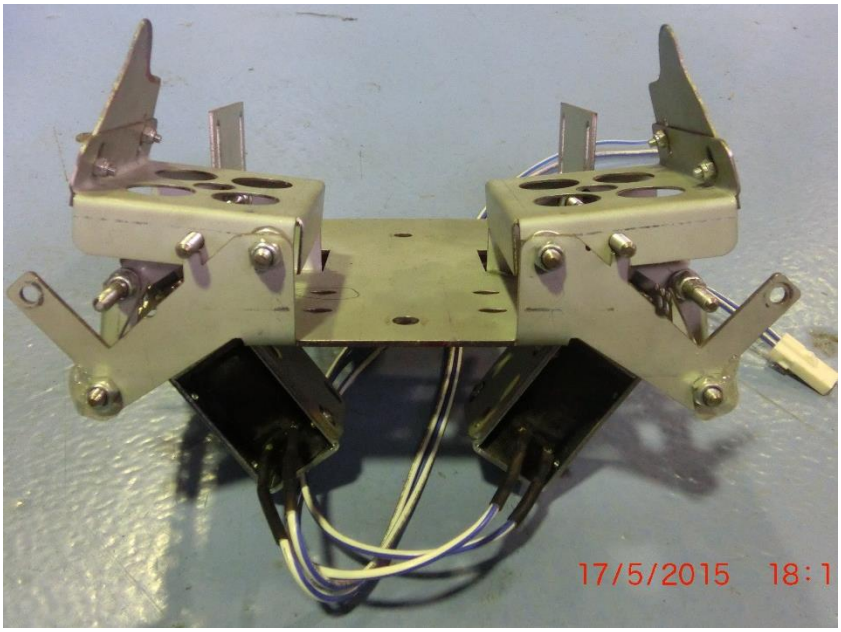


Fig. 2.8 prototype concept 3

Tests results

Testing with this prototype gave very promising results. In the first place, when testing with a longer trigger, it was not able to dual side tip. When the triggers where adjusted to a very small size, it was working great. The prototype worked fast, consistent, and uses a smaller and cheaper solenoid as the current K-carrier solenoid. A disadvantage is that it might be hard to assemble the prototype when it is produced on a larger scale. The solenoid is not flush with the extrusion profile it is mounted on. This was not a requirement when this prototype was designed. Now we know the solenoid cannot stick out underneath, there might be another solution to get the same trigger movement.

2.3.4 Proof of concept 4

Proof of concept 4 is very similar as concept 3, but uses a different mechanism to result in the same trigger movement. Instead of the 3 pivot point mechanism, a cam is used to drive the trigger. This mechanism makes it possible to have the solenoid in another direction, where it can be mounted flush with the aluminium profile. It is nog possible to use the same mechanism in this direction, because there are too many degrees of freedom needed to transform the translation of the solenoid into a rotation

of the trigger plate. Fig 2.9 shows a picture of the cam mechanism applied to the same pivot point as used in concept 3.

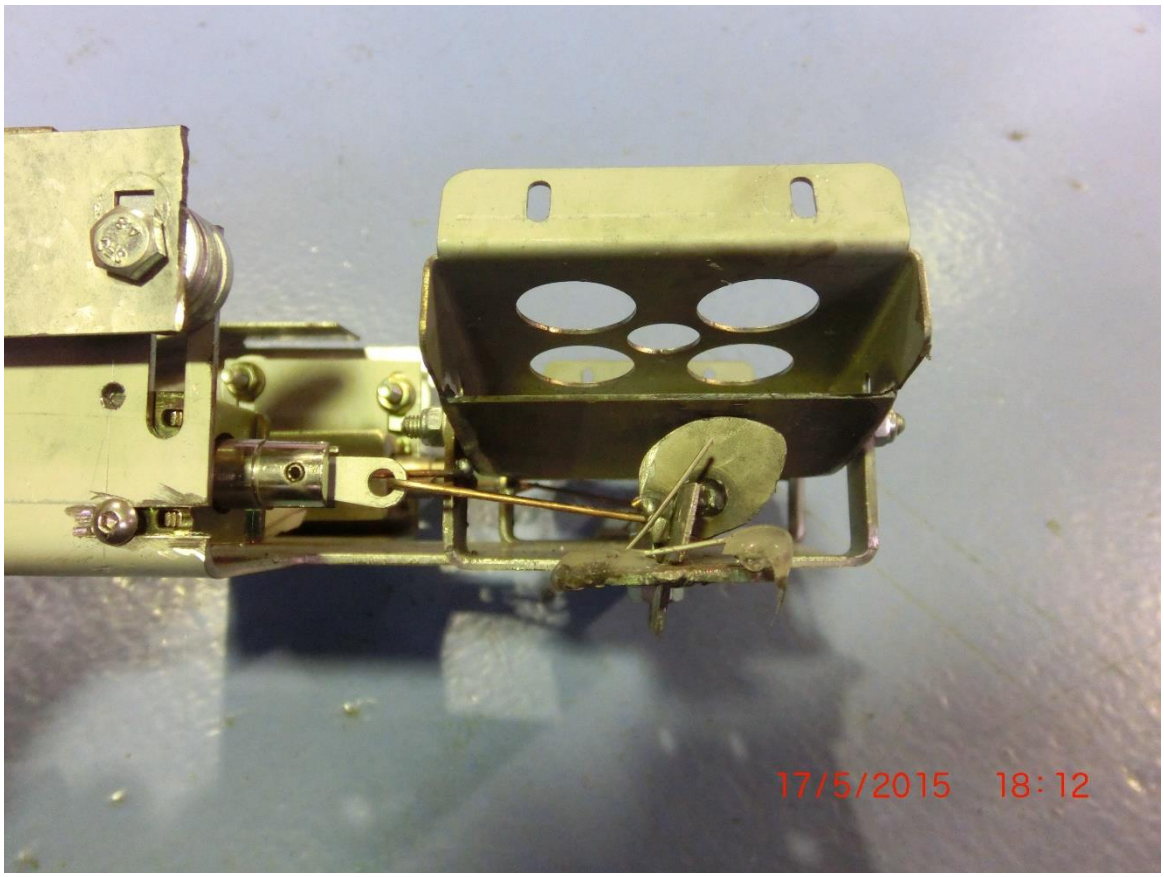


Fig. 2.9 proof of concept 4

Test result

Testing with this proof of concept on the K-carrier gave similar results as concept 3. It works just as fast and consistent, only uses another mechanism to drive and hold the trigger. After some hours of running tests, contact points between the cam and trigger plate were inspected. As expected, a lot of wear is shown at the place where the cam is wearing in the trigger plate. This is definitely a problem that needs to be taken care of when proceeding with this concept.

2.4 Final concept selection

Now every concept is build and tested thoroughly, we can select a final concept using both functional and manufacturing selection criteria. This chapter will describe the different selection criteria that are used, and how each concept scores when tested against these criteria. The concept that scores the most ideal balance between function and manufacturability will be the final concept and will be designed further for large scale production.

2.4.1 Selection table & results

Table 2.1: selection table

		factor of importance	concept 1	concept3	concept 4
Functional criteria	**fast trigger movement**	1	5	3	3
	dual side performance	1	4	4	4
	space for carriers to tip	0,5	3	5	5
	"smooth" tipping	0,8	4	3	3
	tipping consistency	1	4	3	3
	short tipping distance	1	4,5	2,5	2,5
	solenoid flush with extrusion	1	5	1	5
	large (miss)timing range	1	4,5	2	2
	waterproof	1	3	3	3
	ability to use two triggers	0,8	5	2	2
Manufacturing criteria	**minimized amount of parts**	1	4	2	3
	minimized moving parts	0,8	5	2	3
	mechanism wear resistance	1	5	4	1
	minimized amount of joints	1	4	2	3
	solenoid easy to assemble	1	4	1	3
	low production costs	1	4	3	3
	can use parts of H-carrier solenoid	0,7	4	1	1
	min. Expensive tooling needed	0,7	3	4	4
	suited for large scale production	1	4	2	2
	cheap electrical solenoid	0,5	4	3	3
	Total “functional” score:		**38.7**	**25**	**29**
	Total “manufacturing score:		**35,9**	**20,6**	**22.4**
	Total score:		**74,6**	**45,6**	**51,4**

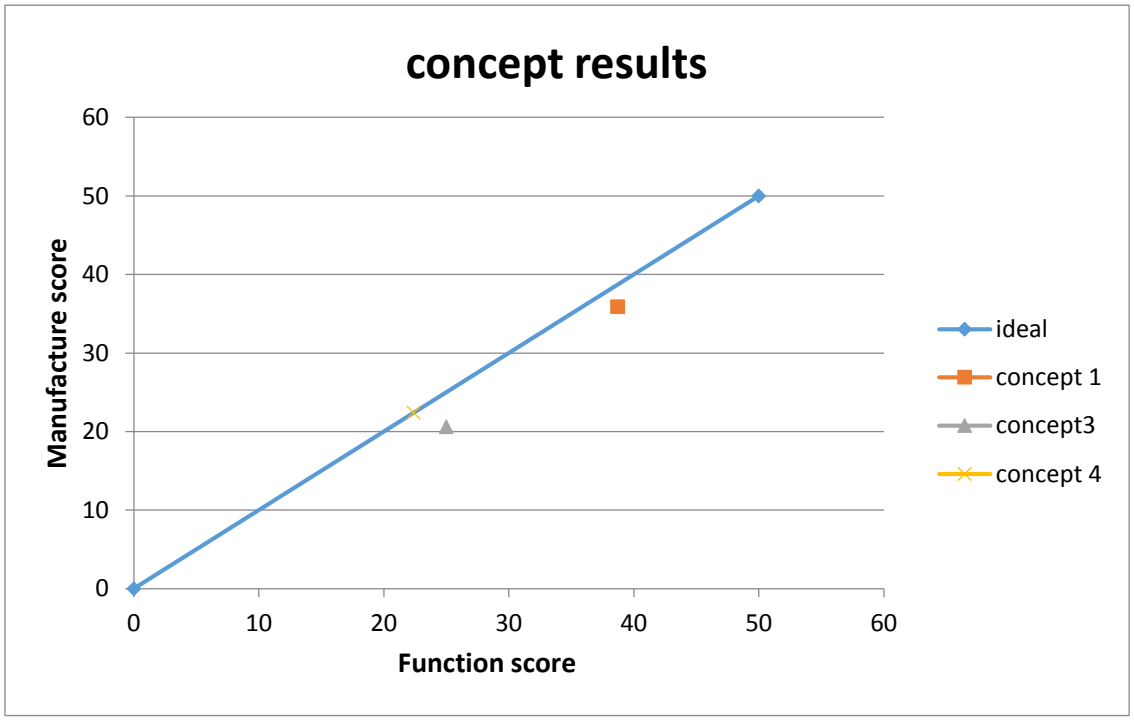


Fig. 2.10 concept result graph

Table 2.1 shows the different selection criteria that are used for selecting a final concept. Each selection criteria has a "factor of importance" which means how important the specific criteria is for concept selection. The value 1 means that criteria is fully important.

Fig. 2.10 shows the graph to compare the different concepts. The blue line displays the "ideal" curve that creates an optimized balance between functional and manufacture criteria. The closer a concept is to this line, the better. Also applies: how higher a concept scores on this line, the better the concept suits all selection criteria.

After having a brief look at the graph above, it is clear that concept 1, side tipping, turns out to be the best concept looking at both function and manufacturability. "Concept 1" will be the final concept and will be optimized and designed further to a model that is ready for larger scale production. In the chapter "Results" this stage of the project will be described further.

3 Results

In this chapter, the results of the project will be described. What are the specific deliverables for Compac sorting equipment after the project is finished? The following deliverables will be described:

- 3D cad model of final design
- Final prototype
- Installation of 10 test units at Phantom, Australia

3.1 3D cad model

After a final concept is selected, a final design can be made of the selected concept. The aim of this final design, is to use standard plastic parts from the H-carrier where possible. Parts that are designed specific for the K-carrier solenoid are the frame, triggers and plastic ramp. The final design will use the same plastic cover and coils as the H-carrier dual side tipping solenoid. Fig. 3.1 shows the 3D cad model of the final design. The 2D drawings for fabrication of the parts can be found in appendix III: "Drawings final prototype".

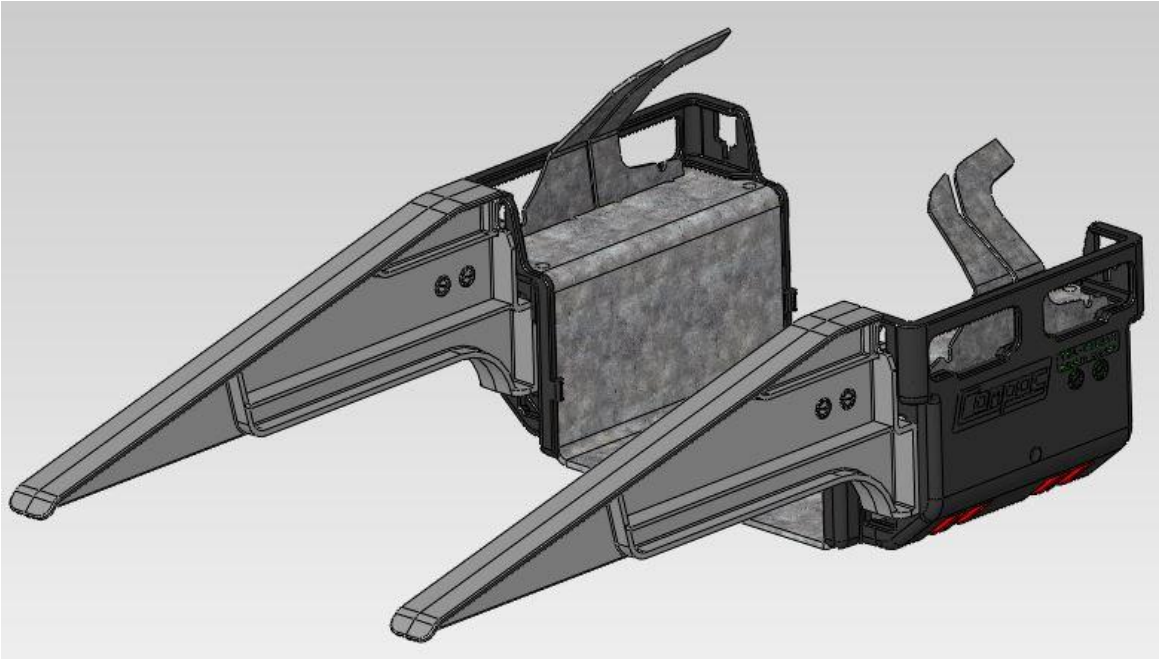


Fig. 3.1 3D model of K-carrier dual side solenoid

3.2 Final prototype.

First, the exact geometry is optimized using the current prototype and high speed video analyses. With this knowledge, an exact design can be made in SolidWorks. (See previous chapter, 3D cad model.) After this final design is finished, the final prototype parts are ordered and assembled in the development centre. This prototype is used to test and optimize the design, before ten test units can be ordered for site trial. Sheet metal parts were ordered at Stainless Design, the plastic ramps were manufactured using the 3D printer available in the development centre. Fig. 3.2 shows a picture of the final prototype after it was assembled. The final prototype gave very good results when tested on the K-carrier machine. After thoroughly testing, small adjustments are made to the design, before ordering 10 test units for site trial. Test results with the final prototype shows the solenoid solution tips the carriers fast, gentle, and very consistent. It does not miss any carrier when 4000 carriers are tipped.

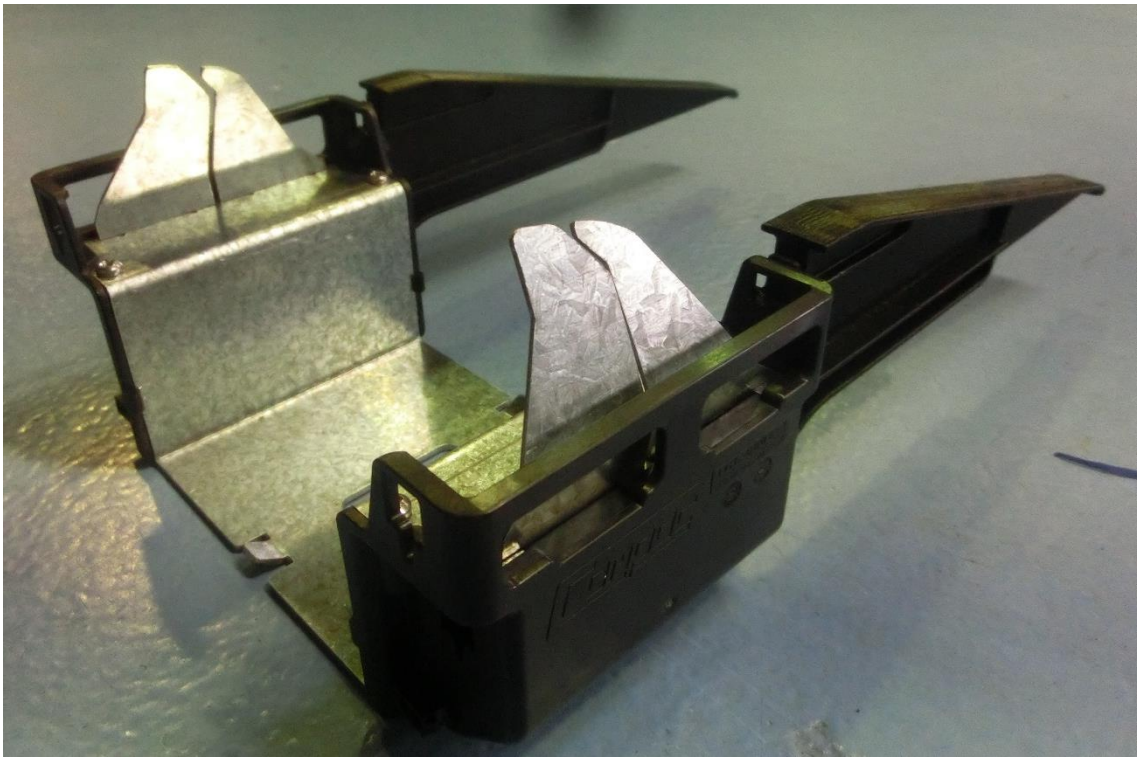


Fig. 3.2 Final prototype

3.3 Site trial

The final stage of this project is the installation of 10 test units for site trial. Ten final prototypes will be ordered and installed at Phantom, Australia. This stage will tell if the costumer, the company that is using the machine, is pleased with the new solution as well. At the time this report is written, this stage is yet to be completed. The test units are almost ready, and will be installed during the following weeks. In some way, we could say this stage is out of the project scope from a graduation point of view. It will be completed after this report is finished and handed in. still, it's an important stage to finish the project in a complete way. Fig. 3.3 shows 9 of the ten test units ready for installation on site.

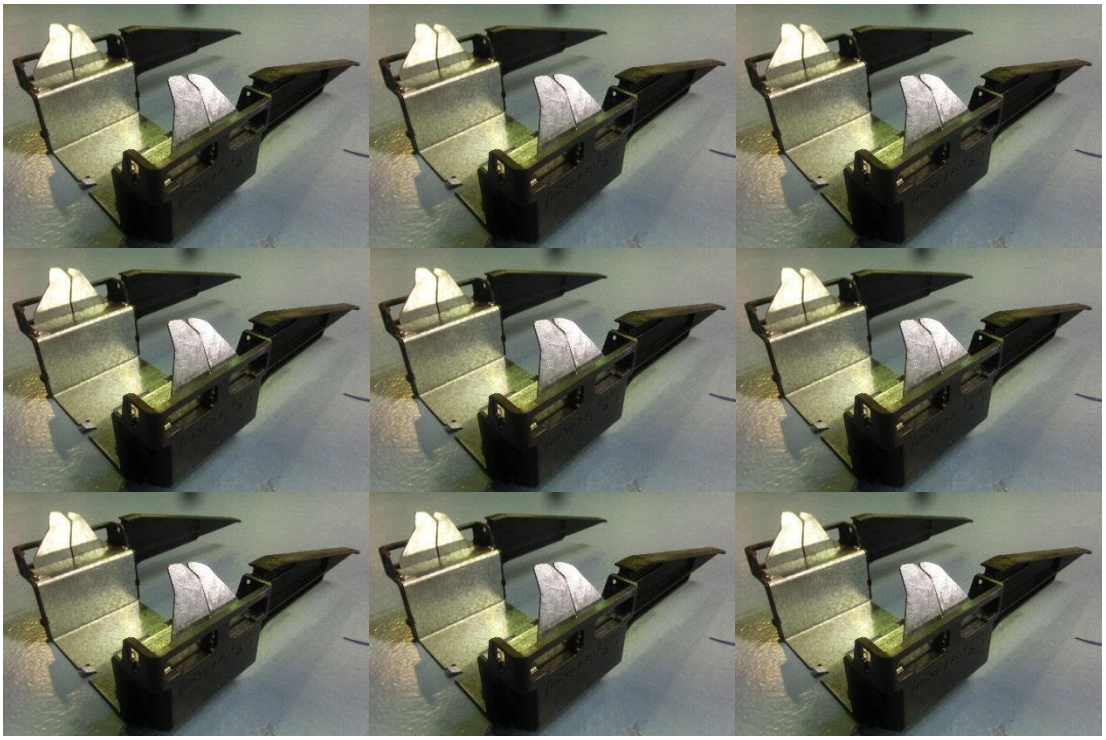


Fig. 3.3 nine test units for site trial

4 Conclusions

This report describes the research and development when designing a new solenoid solution that can tip fruit two ways on the K-carrier machine. There are several conclusions that can be drawn following the chapters Method and Results:

The first conclusion that can be drawn is: there are multiple solutions to tip fruit dual side on the K-carrier machine. Testing each solution against both functional and manufacturing selection criteria, a final solution can be selected that has the best chance of success.

Following experience with H-carrier solenoid, we can conclude that the final solution will lead to a significant cost reduction compared to the current K-carrier solution. As described in chapter 3, the final solution will use plastic parts from the H-carriers solenoid that would otherwise need investment in expensive tooling.

A conclusion that goes beyond the problem statement of this report is: To be a complete engineer in research and development, both analytical and practical skills can be very useful. From a theoretical supported mind set, practical proof of concepts or prototypes can be build and tested to result in a better, more supported concept selection.

Lastly: graduating in New Zealand is great!

5 Recommendations

This chapter will give some recommendations for the person(s) that will proceed with this project after my time at Compac has come to an end. The way to proceed with this project is very dependent from the final site trial results.

When the customer, Phantom, is satisfied with the new solenoid solution and the solenoid performed very well, we know for sure that the final solution works great when tipping light produce like capsicums. This is the type of produce that Phantom handles. However, this result will not tell anything about the solenoids long term performance when tipping heavy fruit like mango`s. The recommendation is to set up a second site trial at a company that handles heavy produce like mango`s, before the solution is released to all K-carriers machines.

When the solenoid works very well with all types of produce, it would be recommended to release one K-carrier machine with dual side tipping abilities. Yet, there are no machines that can actually dual side tip. No problems with dual side tipping are expected since this feature is tested in-house. Still, there might be different results on site when the solenoid is dual side tipping.

Finally: When tipping with the final design solenoid, the carriers will hit the opposite trigger with carriers frame. This is a result of the trigger and solenoid design. It seems not to be a problem, because the carriers still tip very well. If this turns out to be a problem in the future, the recommendation would be to look if the carrier frame moulding tool can be modified, to create a cut-out in the carrier frames. This will make the carriers able to let the opposite trigger untouched. To make to carriers not touch to opposite solenoid side at all, solenoid plastic cover needs a cut-out as well. This will result in an extra production activity before the solenoid can be assembled.

Appendix I: Design notebook

24-02-15

Hi everyone,

I`ve started working at Compac last week on Wednesday. I don't have a Computer workplace yet, but I will have one set up this week. I like working in the development centre so far, very interesting things going on here. I first had a great introduction from Sheldon, really learned a lot about the details off my assignment. It helped great to see the actual K-carrier in real live and see how the rollers tip over. When I started working, I first built a little ramp for testing on the multi-lane H-carrier. Very nice job just to get things started, I loved to work in the workshop on my first day to get used on working there.

On my second day, I met Tim Jenkin, who will be my internal mentor and will help getting in the right direction with this project. He found an older prototype build for the K-carrier. It is very similar as the H-carrier solenoid, but it seemed to have some problems with tipping the K-carrier rollers both ways. That day I've filmed some footage on a high frame rate of the tipping rollers from the K & H carrier to analyse what's happening at high speed tipping. With this information, I came up with an idea to tip the rollers not just from aside, but let the trigger come in from underneath as well.

I started building a "proof of concept" to see if the idea might work. The idea is to let the trigger come in at an angle, so it has both a vertical and a horizontal translation. This way, the roller might be able to tip further to both sides, without smashing into to the other trigger. (That's what happening with the current prototype.) I had something finished on Friday, but forgot to put the ramps on. When one wheel by accident tipped the wrong way, it crashed into the trigger and the model was demolished. :-(But no worries, I finished a new model yesterday using the same baseplate. It took some time to let the trigger come in from the right angle, but now it seems to work. Just tested the idea on tipping the rollers with some heavy fruit. It tips the rollers well. What I wanted to test with this model is if the rollers can pass the trigger when tipped from the other side. As it seems, this worked out well. The rollers are now able to tip a lot further and will still be tipped when activating the trigger.

When I showed the idea to Tim, he thought it was a good idea as well. There are a lot of things that need to be figured out, therefore I might need SolidWorks. I will have a computer this week, so I will start with that part from there. I have some more ideas to test, but they need some tuning in SW first.

Pfiew… quite a long story to read maybe, I didn't know about jira until now. From now on, I will put up an update of the project more frequently. After all, I`m happy with the start up here at Compac. Time fly`s when working here.

Regards,

Joris Splinter

27-02-2015

Dear Followers,

After I had set up my computer this week, I started working in SolidWorks to figure out the optimized dimensions for an idea I came up with. Here above, I will post some pictures of the tipping mechanism in SW. It might work, or there might be some problems using a solenoid to lift the trigger. Anyway, it will be possible to let the rollers tip a lot further. If I have figured out the idea a little bit more, the next step might be to build this mechanism in the development centre to see if it will work on the K-carrier. The idea is that the solenoid don`t need to hold the trigger once it is lifted and "locked". Please let me know if the pictures need more clarification.

Regards, Joris

13-03-2015

Things progress positively, after several tests at different machine speeds the solenoid mechanism seems to tip the fruit consistent. Some problems occur from time to time when a real big heavy mango pass, but this can be a carrier problem, because they can be locked, and even won't be tipped by the all-tip ramp. Recommended not to leave the machine unattended doing tests with real heavy fruit, cause this "locking" can smash the mango in the back of the machine. I used Max's Arduino/sensor to tip the fruit at the same timing each time.

Tipping light fruit at a higher speed of 450 cpm seems to work very consistent, as the machine misses about 2 hockey balls/hour with 50 hockey balls running in the machine. At the first test, it missed a little bit more, (5/hour) but I found out that this was caused by a broken latch of one of the carriers. (Probably caused by an earlier crash with huge mango)

For the proof of concept I used the original big solenoid and used it at 24V. This works well, but I'm aware we want to get rid of this expensive big custom solenoid. Therefore, I bought two cheap, standard solenoids with Tim at Jaycar. I tested these on the current proof of concept, and it worked! They were a little slower, but will definitely work fast on a lighter version. The solenoids can be bought from china for around $5, 00.

This week, I started designing a lighter prototype out of sheet metal in SW. I completed a 3D model with the same geometry as the proof of principle. I started to make 2D drawings for production today, and got some very helpful tips and tricks from sheet metal expert Jason M.C. Donald. He explained me all about Compac standard templates, and how to dimension the bends and lengths.

I think I will finish the drawings and DXF files next week. From there, Jason will guide me through the process of getting the parts in production.

In the meantime, I will be able to do more testing when waiting for the parts to arrive. Once the parts are finished, more testing will be done with

tipping both ways. Depending on these results, the design will be improved / developed further.

If someone is interested in the working mechanism so far, please come over any time and I can show the machine running and the mechanism tipping.

Regards, Joris

31-03-2015

Last week felt like Christmas, when my brand new laser cut and folded prototype arrived. :-) After I had put it together, you could instantly feel how light it was to move the mechanism. The basic small solenoid is able to move it lightning fast using 24V and drawing 1 Amp.

I mounted the duel side solenoid on the K-carrier and tried to tip some fruit. It worked great, tipping the fruit to one side, the carriers did not touch the opposite trigger. After some simple tests, Sam & Sheldon helped me set up the sizer to tip every other carrier, left, right, left, right, left, right, etc… just to see if it was fast enough to work that fast. When we tried it, it didn`t work at al :-(After shooting some footage of the tipping, it turned out there was not enough space for the trigger, because it was hitting the roller of the other carrier in front when it was tipped towards it.

Good news is that it works now, but I had to grind the trigger to a minimized shape. It still tips the carriers pretty good. Sometimes it miss tips the lither hockey balls, when testing both with heavy fruit and hockey balls. I am still trying to figure out why and how this is happening. It looks like the solenoid doesn`t even tries to tip it from time to time, so it might be a problem with the weighbridge. I have set up the carrier with hockey balls and heavier fruit, all next to each other to see the duel side tipping abilities of the prototype. It tips the heavy fruit to the left, and the hockey balls to the right. You can see the result in the video I placed in this folder:

B:\Design-mechanical\General Design\Test-Trial Results\2015\TCA-533 RD098 K carrier duel side tipping\Proof of Concept\Video footage Prototype1

It looks pretty good, but I am working on the consistency now. Sometimes it never misses a carrier for minutes, and sometimes in let`s 10 fruits next to each other all go passed. I think the weight bride plays a part in that as well. This week, there will arrive a new Z-plate which may improve the accuracy, since the current one is not straight enough.

Regards, Joris

08/04/2015

Tests with the prototype are looking very good. After Sheldon helped me setting up the weightbridge and tarring it properly, the timing is a lot more consistent and the fruit is being tipped better. It`s safe to say it miss tips around 1 mango after 1 hour of running the machine with both heavy and light fruit.

After I discussed the current prototype with Sheldon, he told me it is a good idea to figure out the minimum distance between two duel side solenoid that is needed to let the fruit tip before it hits the other ramp. This turned out to be 600 mm, which is all right regarding to the K- carrier specs. Sometimes it does not look very clean as some mangos are not fully tipped before hitting the ramp of the second solenoid. That's one of the reasons I want to do some tests with a different latch that has more slope. A latch more similar to the H-carrier latch. As shown in the picture right, I modelled an add-on for the current latch, so I still can use the stiff structure of the moulded latch. This one is 3D printed as we speak, so that gives me time to update my one note ;-)

17/04/2015

Last days I have been looking for a way to get the solenoid flush with the aluminium profile, instead of having it pulling from underneath. This seems to be not very straight forward, and brings a lot of challenges to solve. I have a couple of concepts that seems to work in SolidWorks, but I doubt if they will work on the real prototype as well.

Before I wanted to go into this challenge deeper, I wanted to have a double check to see if the circular motion around the pivot point I determined, really is a big advantage compared to sideways tipping around another pivot point. To find out, I made the sketch you see here at the right.

You see the pivot circle of the trigger on the prototype I designed compared to a pivot point that would result in sideways tipping. This sketch shows how much more space the new pivot point gives us. I shows what Tim already told me, it is really great to use the new pivot point. Now the big challenge will be to get the solenoid working in another direction…

28/04/2015

Last week, I discovered something about the duel side tipping solenoid that might be real game changer. It might as well change the complete story I wrote here above. In the previous note, I explained why I came up with the idea to move the trigger around another (more complex) pivot point. The advantage of this trigger movement was very noticeable when testing with a relatively large trigger. It made tipping possible without hitting the opposite trigger with the carrier frame.

In the note at 31-03-2015 I explained why I had to bring the trigger shape down to a small, minimized size to make the dual side tipping work. So far so good, the new mechanism worked with the short trigger and tipped the fruit fast and pretty consistent left and right.

Last week I started working on the paperwork. Tim showed me the new one note template for R&D projects. The purpose was to make the paperwork more organized and more properly. Here is the link to this one note:
PDSG-RD098 K Carrier Dual Tip Solenoid

When I was writing about the different concepts, I also wanted to explain and proof why the new pivot point is the selected concept. Not only for the readers, but also as a double check for myself and to be sure it is justified to get rid of the sideways tipping concept for the K-carrier.

So to do one more test, I mounted the sideways tipping prototype on the machine to make some videos of the carriers smashing to hard into the triggers. Just to play fair, and make the prototype comparable with my selected concept, I grinded the triggers to a similar, smaller size. I turned on the machine, tipped one trigger, ready to see the carriers hit the opposite trigger… and it didn`t?!!? It tipped well, smooth and duel side. The short trigger allowed to carriers to be tipped passed the end of the trigger and not bounce back. Complete opposite results as with the longer triggers tested earlier. I felt very confused, funny, happy, and a little bit stupid. ;-) This might be a very simple, cheap solution very similar as the H-carrier solution.

After some more tests, and positive looking results, I made a 3D model in SW to see if I could make a new frame that could use the same parts that are already in production for the H-carrier duel side solenoid. It looked good, so I modified one of the existing H-carrier solenoid frames and assembled it with all the plastic parts and triggers. It looked like a finished product ready for production.

When I tested this prototype on the machine, it was amazing how good it worked. I definitely need to tweak around with the position and slope of the triggers a little bit more for better consistency, but it looks very good already.

If this concept turs out to be a good solution, it might be possible to make a new frame, a new trigger, maybe a new ramp, and use the exact same plastic cover and coils as the H-carrier. I think this will result in a huge cost reduction, as the plastic cover needs the most complex moulding tool for production.

I will attempt to optimize the tipping further, as the two triggers are opening up a lot more possibilities for sloping the trigger.

Joris

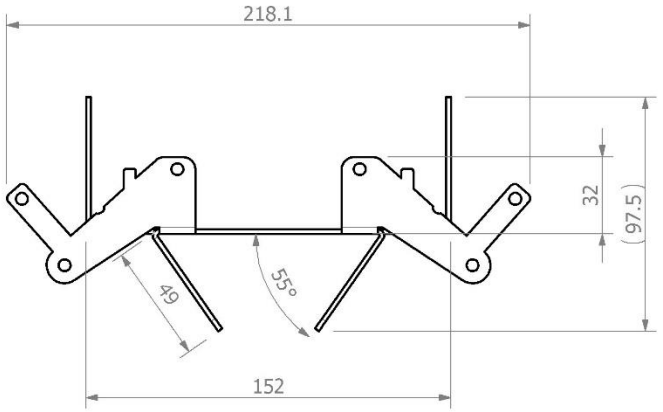
PS: the reason I did not find any positive results with the side tipping prototype before, is because I really thought the K-carrier needed a long and gradual sloped trigger. Using such a trigger, there is no way to make the sideways tipping work. Therefor I designed the new pivot point prototype. Via a long design route, I might end up with the original idea that is used on the H-carrier as well. The design process I have been trough is definitely not a waste of time, although it might not result in a final product. I learned a lot about the K-carrier and how to tip it the best way. Now I can apply this knowledge to optimize the side tipping solenoid and make a final design.

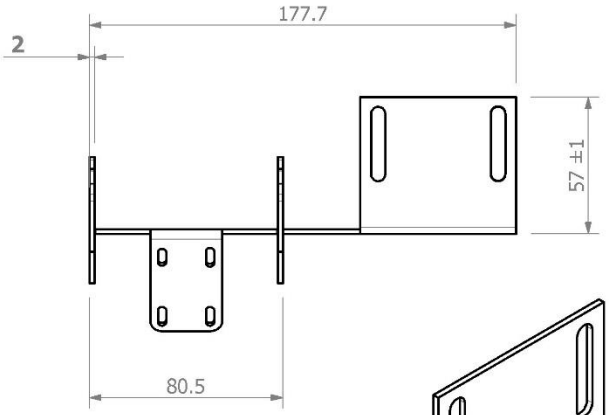
25-05-2015

Test results with new prototype look very good. Tested with real capsicums. Final design is ordered and will arrive this Tuesday. After the final in-house test gives good results, 10 test units will be ordered to be installed at Phantom growers, in Australia. I look forward to go there for the final test on site. I think it`s a very good way to finish the project. After the site trial is done, I think my time at Compac will almost come to an end. I don`t look forward to go back to Holland. :-(I talked with my girlfriend about coming back to NZ for 2 years. Who knows, maybe there will be a job opportunity here at Compac and I might come back and work here for a longer period. :-)

Appendix II: Drawings concept 3

Please see the following pages for the 2D drawings of concept 3





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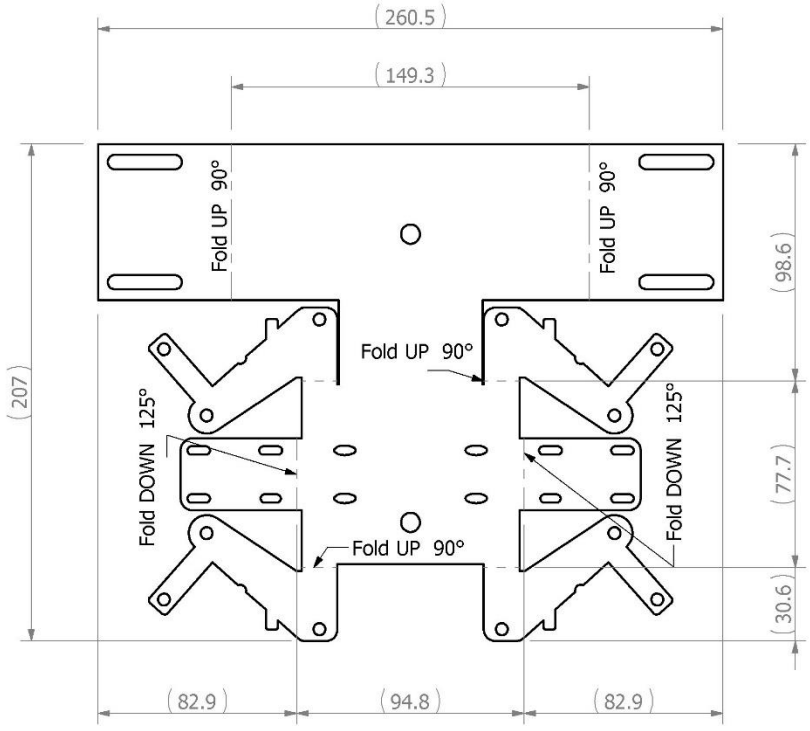

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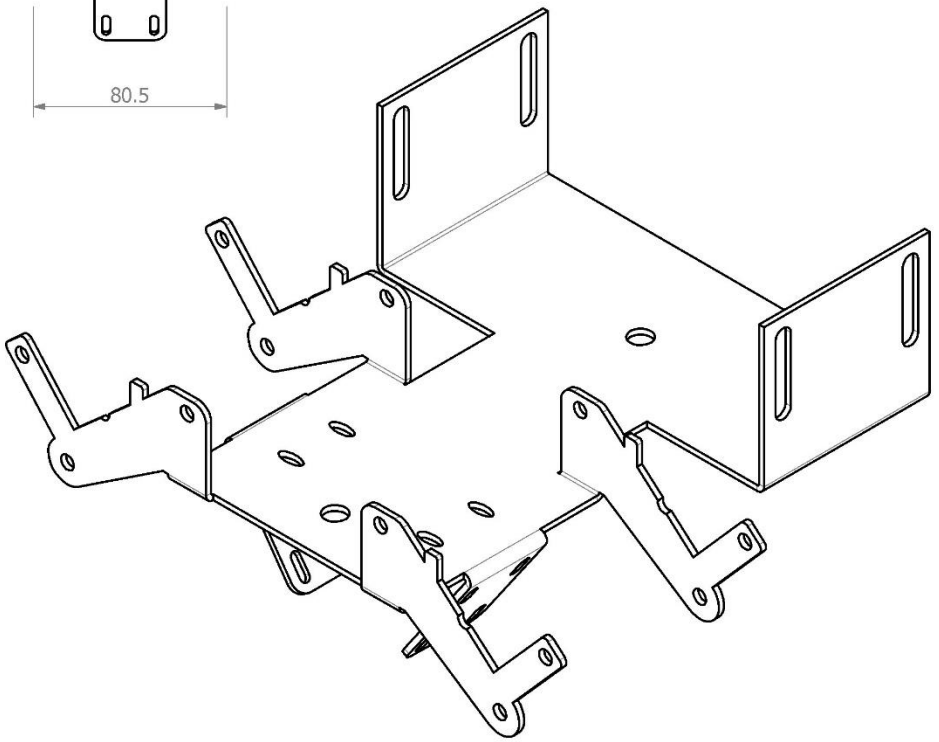

Note A: All dimensions are external unless otherwise specified.
Note B: Part is not fully dimensioned - refer to additional data.
Note C: Folding dimensions on flat pattern are for reference only.
Note D: Maximum allowable internal bend radius = 1.5x Material thickness.
Note E: Deburr all sharp edges.
Note F: Welding Symbols as per ISO 2553:1992 (ES013)

REV	DESCRIPTION	ECN No	DATE	BY

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PO BOX 13-516
ONEHUNGA
AUCKLAND, NZ
PHONE: +64-9-634-0088
www.compacsort.com

MATERIAL	Electro-Galvanised Steel Sheet (JIS G3313 SECC)		
FINISH -	NEXT OP. -	UNITS = mm	
Cutting Tolerances (unless specified otherwise)	±0.3mm		
Folding Tolerances (unless specified otherwise)	±0.5mm, ∠ ±1°		
PART NUMBER	XJSP-3001	MASS	0.542 kg

TITLE	Baseplate				
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DWG NO.	XJSP-3001				REV A1

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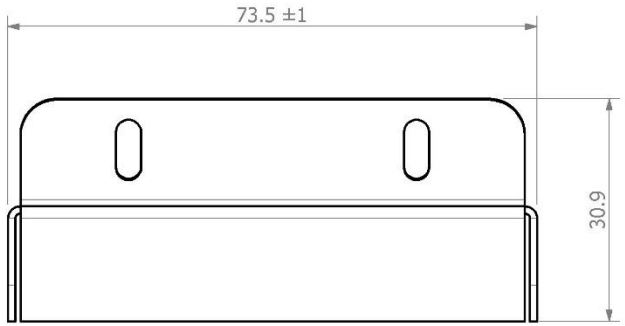

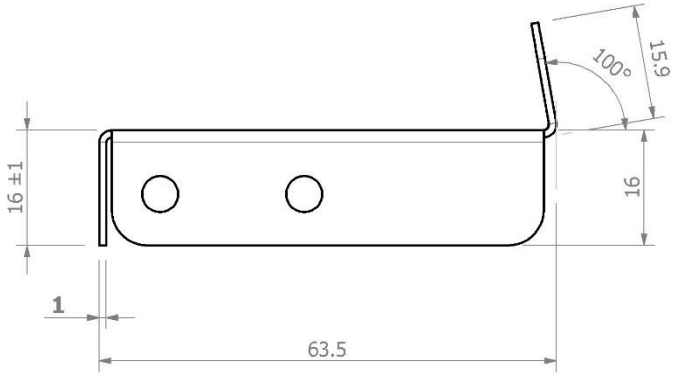

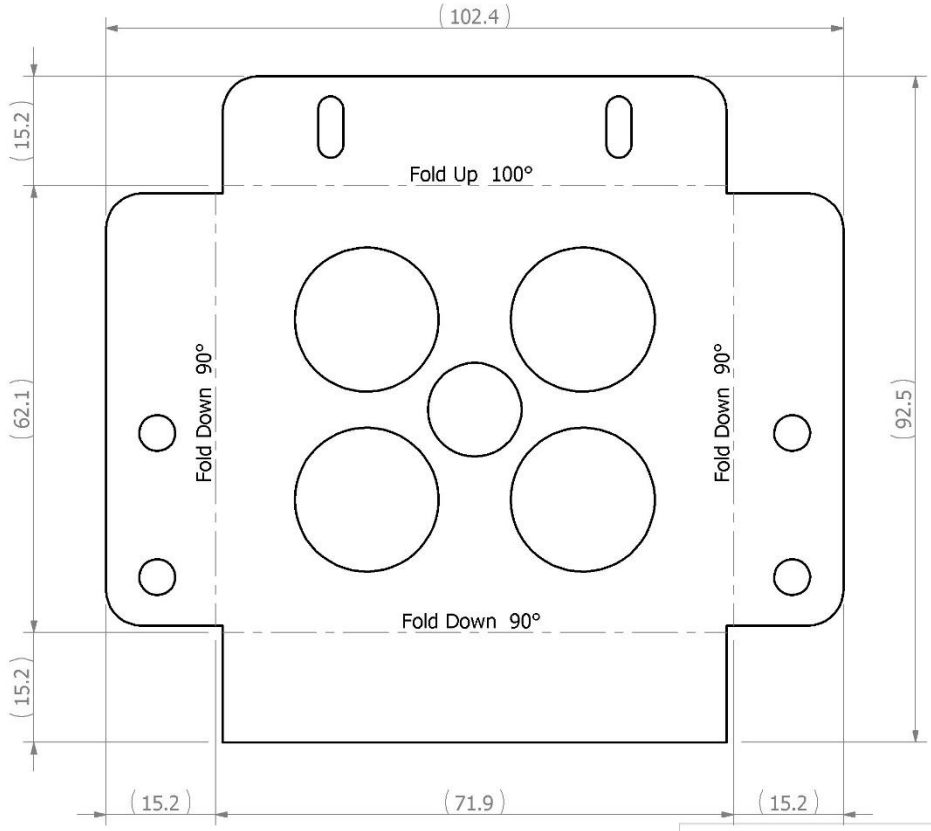

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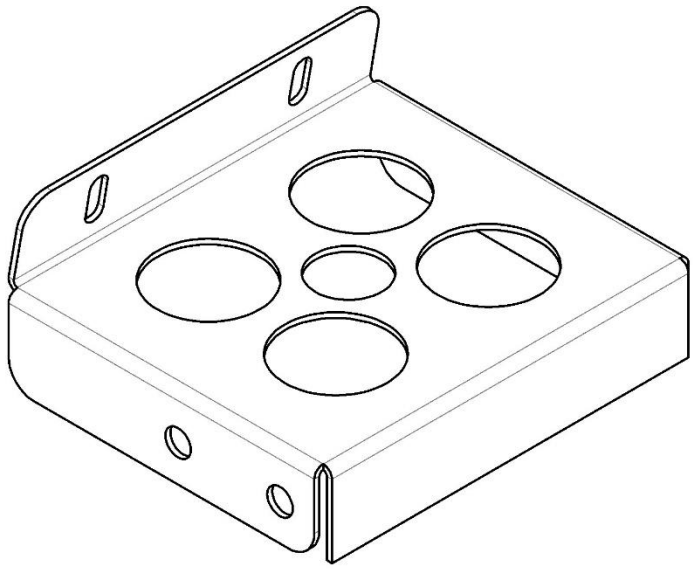

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FINISH -	NEXT OP. -	UNITS = mm	
Cutting Tolerances (unless specified otherwise)	±0.3mm		
Folding Tolerances (unless specified otherwise)	±0.5mm, ∠ ±1°		
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TITLE	Plate-Top				
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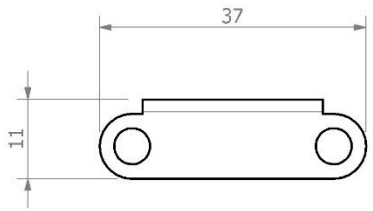

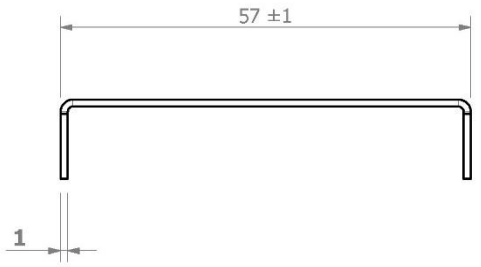

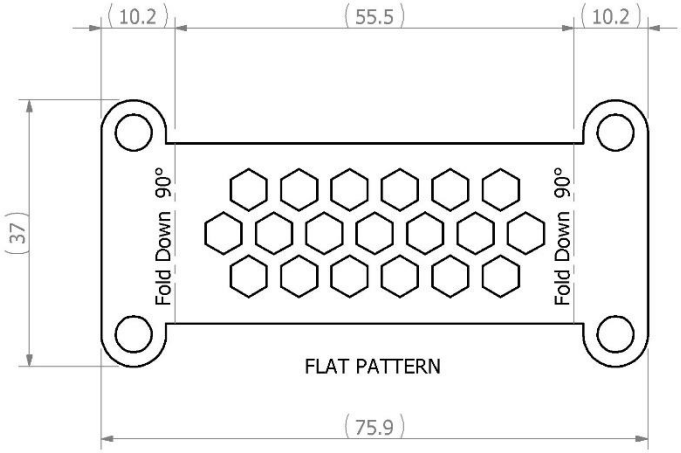

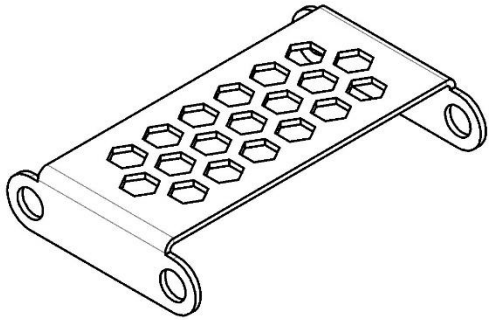

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Cutting Tolerances (unless specified otherwise)	±0.3mm		
Folding Tolerances (unless specified otherwise)	±0.5mm, ∠ ±1°		
PART NUMBER	XJSP-3003	MASS	0.012 kg

TITLE	Hinge1				
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DWG NO.	XJSP-3003				REV A1

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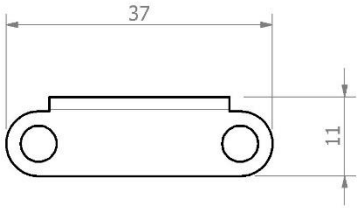

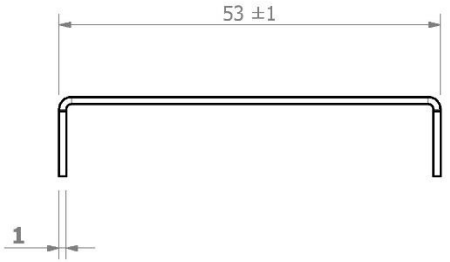

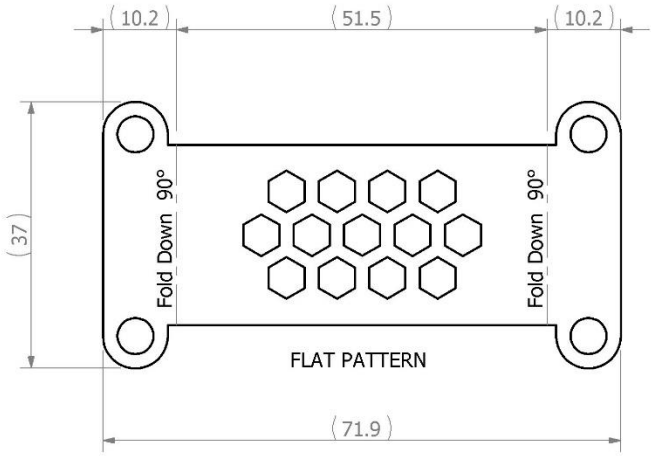

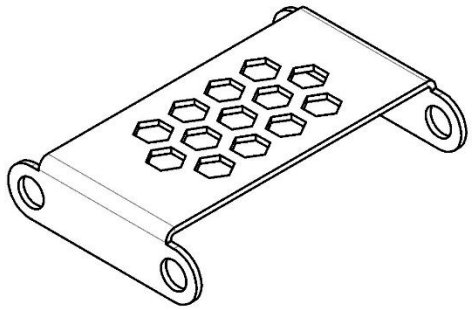

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PART NUMBER	XJSP-3004	MASS	0.013 kg

TITLE	Hinge2				
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DWG NO.	XJSP-3004				REV A1

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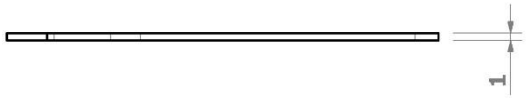

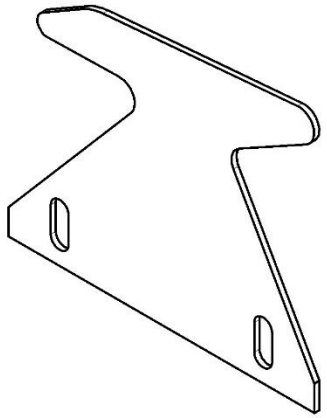

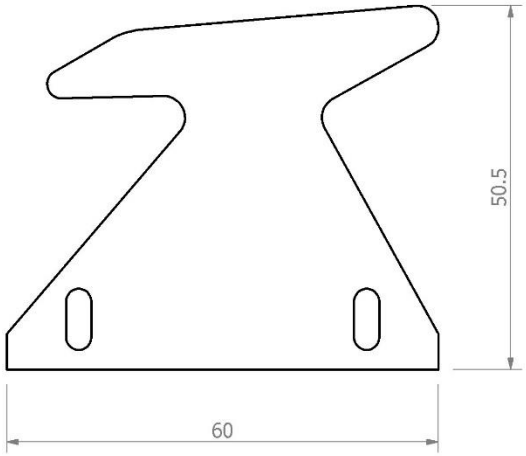

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NEXT OP.: -
UNITS = mm
Cutting Tolerances (unless specified otherwise): ±0.3mm
Folding Tolerances (unless specified otherwise): ±0.5mm, ∠ ±1°
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MASS: 0.015 kg

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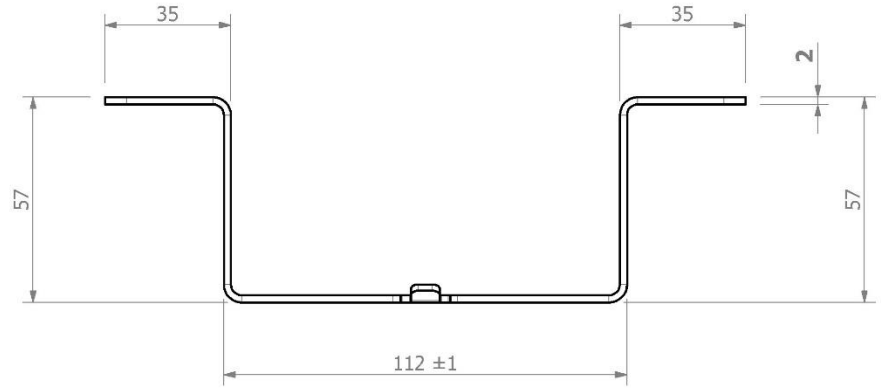
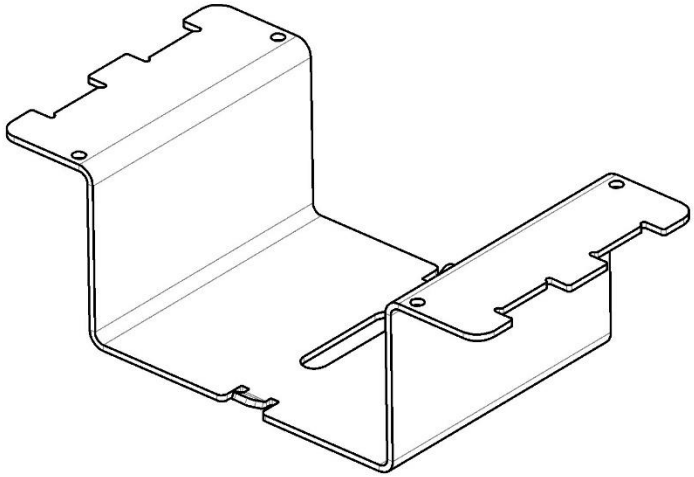
DRAWN: JSP 17/03/2015
CHECKED: JM 17/03/2015
THIRD ANGLE PROJECTION
SHEET: 1 of 1
DWG NO.: XJSP-3008
REV: A1

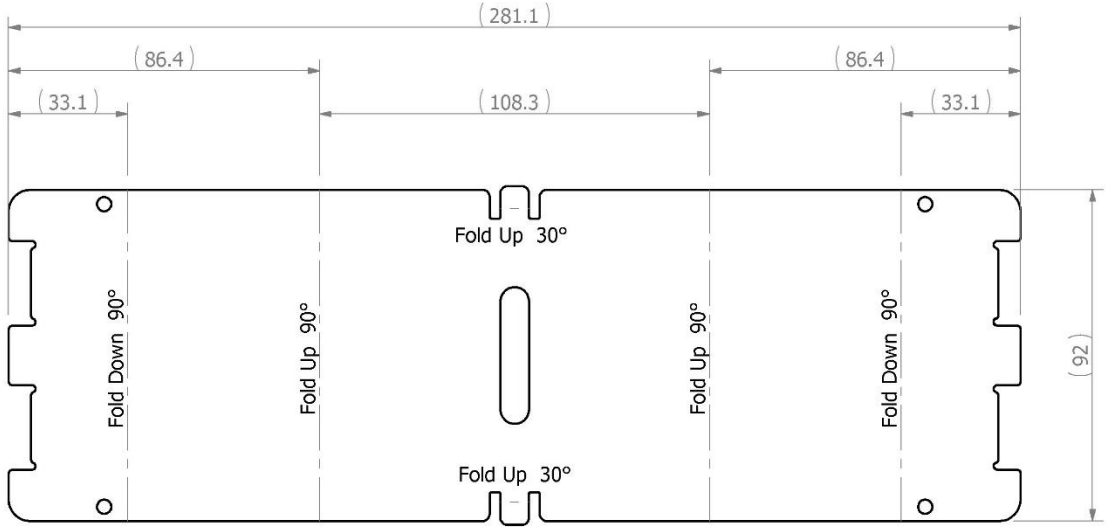
Appendix III: Drawings final prototype

Please see the following pages for 2D drawings of the final prototype

QUANTITY







FLAT PATTERN

Note A: All dimensions are external unless otherwise specified.
Note B: Part is not fully dimensioned - refer to additional data.
Note C: Folding dimensions on flat pattern are for reference only.
Note D: Maximum allowable internal bend radius = 1.5x Material thickness.
Note E: Deburr all sharp edges.
Note F: Welding Symbols as per ISO 2553:1992 (ES013)

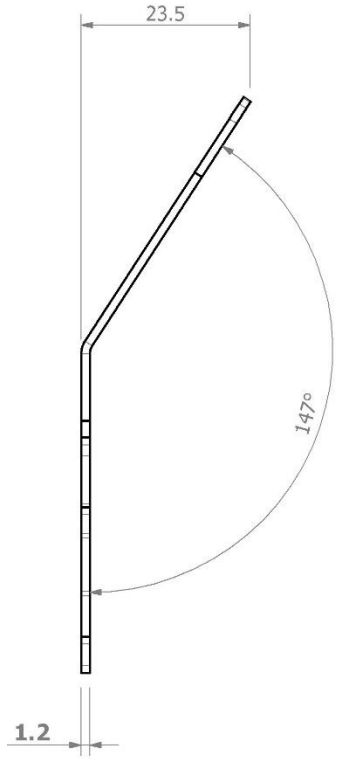
REV	DESCRIPTION	ECN No	DATE	BY

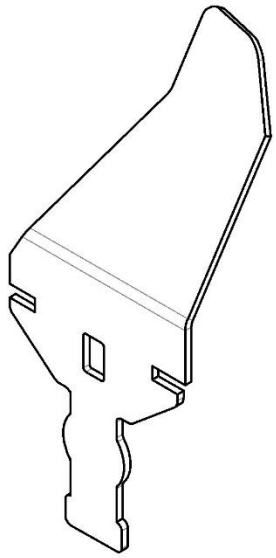
compac
COMPAC SORTING EQUIPMENT LTD
11 SPRING ST
PO BOX 13-516
ONEHUNGA
AUCKLAND, NZ
PHONE: +64-9-634-0088
www.compacsort.com

MATERIAL			
FINISH	NEXT OP.	UNITS = mm	
Cutting Tolerances (unless specified otherwise)	±0.3mm		
Folding Tolerances (unless specified otherwise)	±0.5mm, ∠ ±1°		
PART NUMBER		MASS	kg

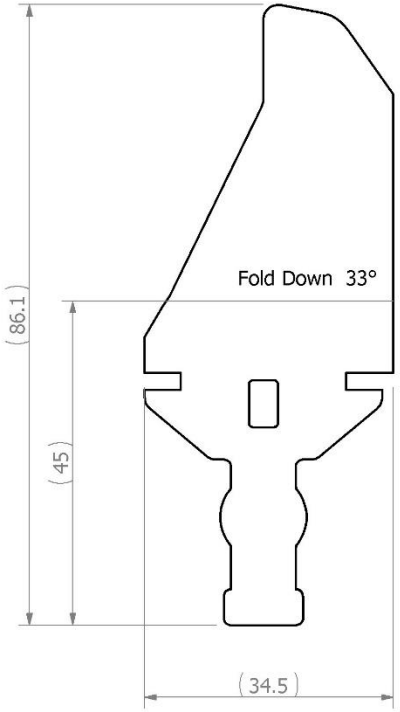
TITLE					
DRAWN	JSP 30/04/2015	CHECKED	JSP 30/04/2015	THIRD ANGLE PROJECTION	SHEET 1 of 1
DWG NO.					REV

QUANTITY
LH
RH





FLAT PATTERN



LEFT-HAND PART IS SHOWN (XJSP-3014+1-Z-L)
MIRROR TO CREATE RIGHT-HAND PART (XJSP-3014+1-Z-R)

Note A: All dimensions are external unless otherwise specified.
Note B: Part is not fully dimensioned - refer to additional data.
Note C: Folding dimensions on flat pattern are for reference only.
Note D: Maximum allowable internal bend radius = 1.5x Material thickness.
Note E: Deburr all sharp edges.
Note F: Welding Symbols as per ISO 2553:1992 (ES013)

REV	DESCRIPTION	ECN No	DATE	BY

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11 SPRING ST
PO BOX 13-516
ONEHUNGA
AUCKLAND, NZ
PHONE: +64-9-634-0088
www.compacsort.com

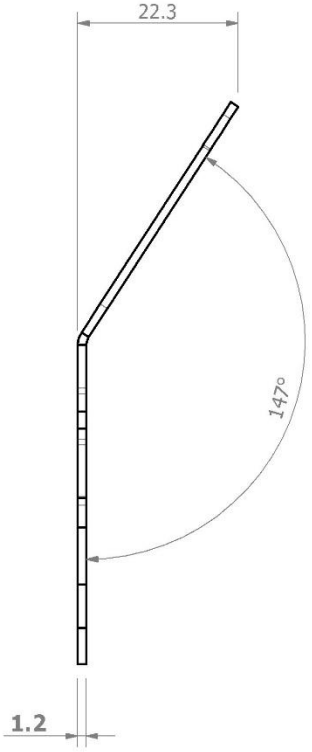
MATERIAL: Pre-Galv High Tensile Sheet (JIS 3302 SGH570)
FINISH: - | NEXT OP.: - | UNITS = mm
Cutting Tolerances (unless specified otherwise): ±0.3mm
Folding Tolerances (unless specified otherwise): ±0.5mm, ∠ ±1°
PART NUMBERS
LH XJSP-3014+1-Z-L
RH XJSP-3014+1-Z-R
MASS: 0.017 kg

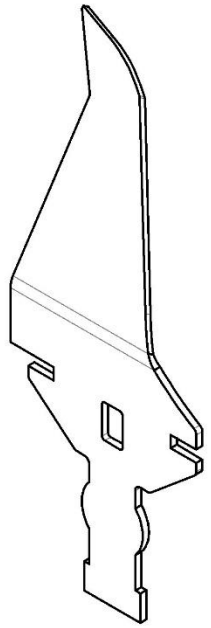
TITLE: Arm2-Dual Soft Tip GH

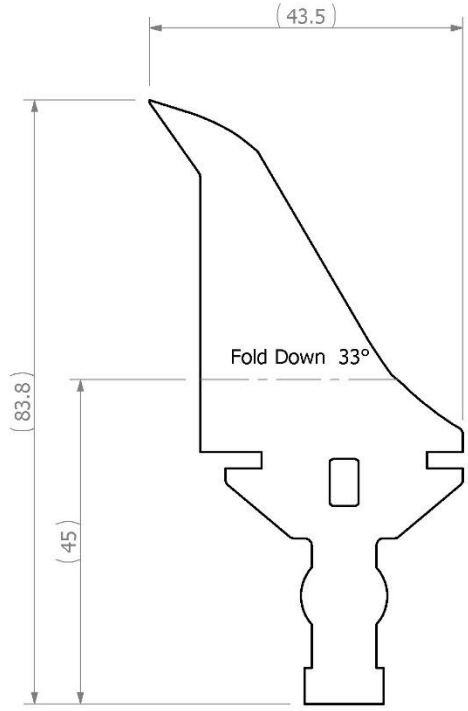
DRAWN	CHECKED	THIRD ANGLE PROJECTION	SHEET
JSP 1/05/2015	JSP 1/05/2015		1 of 1

DWG NO.: XJSP-3014+1-Z
REV: C1

QUANTITY
LH
RH







FLAT PATTERN

LEFT-HAND PART IS SHOWN (XJSP-3015+1-Z-L)
MIRROR TO CREATE RIGHT-HAND PART (XJSP-3015+1-Z-R)

Note A: All dimensions are external unless otherwise specified.
Note B: Part is not fully dimensioned - refer to additional data.
Note C: Folding dimensions on flat pattern are for reference only.
Note D: Maximum allowable internal bend radius = 1.5x Material thickness.
Note E: Deburr all sharp edges.
Note F: Welding Symbols as per ISO 2553:1992 (ES013)

REV	DESCRIPTION	ECN No	DATE	BY

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AUCKLAND, NZ
PHONE: +64-9-634-0088
www.compacsort.com

MATERIAL	Pre-Galv High Tensile Sheet (JIS 3302 SGH570)		
FINISH -	NEXT OP. -	UNITS = mm	
Cutting Tolerances (unless specified otherwise)	±0.3mm		
Folding Tolerances (unless specified otherwise)	±0.5mm, ∠ ±1°		
PART NUMBERS LH XJSP-3015+1-Z-L RH XJSP-3015+1-Z-R		MASS 0.014 kg	

TITLE	Arm1-Dual Soft Tip GH				
DRAWN	JSP 1/05/2015	CHECKED	JSP 1/05/2015	THIRD ANGLE PROJECTION	SHEET 1 of 1
DWG NO.	XJSP-3015+1-Z				REV B1