

10. New Zealand's drive for premium quality fruit and vegetables has led to high technology grading systems that lead the world.

On the back of New Zealand's world class fruit and vegetables exports, original design and development of grading and sorting equipment has been happening for over 40 years and we now have technologies that dominate in markets many times larger than New Zealand production. So how did these New Zealand companies get to this position? Lynx Horticultural Systems: *"Because we are an export country. Groups like Zespri have done us all a great favour. Their insistence of quality in the market place is the benchmark ... By focussing on quality, this has pulled manufacturers into chasing that... our premium products are the benchmark."* The continuing drive for faster and better systems has been a major contributor in keeping export produce competitive and at the formative stages, a number of companies benefited from research funding support.

In the mid 1950s, egg graders were used for grading kiwifruit but could only weigh about 0.5 tonnes per day. In 1964, John Hancock at Te Puke designed the *Orbit Grader* and his four-lane machine could accurately grade up to 14 tonnes of kiwifruit in an 8 hour production day. Once a small computer was available for \$3,000, instead of \$50,000, the days of the clockwork Orbit were over. In 1984, AWA at Porirua commenced work on their Lynx graders as did Hamish Kennedy a graduate from Auckland University who founded *Compac Sorting Equipment*.

Compac first exported their machines to France in 1991 and now lead the world in optical sorting of fruit with exports to 17 countries. A single lane of a Compac machine can sort by size, colour and sweetness, and stitch together 30 images to recognise whether a small blemish is the same or different from a previous one – all at the rate of 10 per second. A 40 lane installation in California can process 900 tonnes of citrus in 8 hours.



60% of *Lynx Horticultural Systems* production is sold offshore including to South Africa where a 10-lane Lynx machine grades apples, pears, plums, stonefruit on the one plant, and in USA in Oregon State, the largest pears crop in USA, where Lynx machines dominate.

BBC Technologies located near Hamilton who lead the field in grading equipment for small berries such as blueberries, now sell 80% of new berryfruit sorting machines sold in the USA.

WYMA Engineering, located at Hornby, Christchurch started in the 1970s repairing farm implements and grading machines. In 2004 turnover was \$8 million with 70% of sales going offshore. *"In Canada we have a client where we have replaced equipment that is only about three years old, but technology that NZ would regard as 20 years out of date."* When interviewed, WYMA were building a Carrot Wash Line for export to Switzerland.

Oraka Technologies located at Cambridge are a world leader in machinery for grading asparagus, generally regarded as a difficult crop to grade. Oraka systems are being applied to carrots, pineapples and other crops with their graders sold in 10 countries, including to countries with high labour costs such as USA and Australia, and in countries with low labour costs such as Mexico, Peru, and the Philippines.

The combined export values of the small number of companies cited in this study is over \$40 million annually – and commentators said there are a number of other companies also exporting equipment and systems for processing fresh produce. A projection suggests that New Zealand could be exporting around \$100 million in produce grading and handling equipment before 2010. There is therefore merit in recognising the value of Knowledge Wave type thinking and resources being applied to New Zealand's advanced horticulture industries where New Zealand has proven market leadership. One equipment manufacturer found that their small company had to bring together a wide range of skills including those in electronics, optics, optoelectronics, computer, software, industrial robotics, mechanical engineering and agricultural. All of these skills were available in New Zealand – and at a world-class level.

1. Background

Early fruit graders measured weight or diameter and were very slow by comparison to today's needs. To speed the process and gain more accuracy, a number of machines were adapted. In kiwifruit, egg graders were popular in the 1950s.

At one point in the early 1960s, a group of growers determined that the volume of kiwifruit coming to harvest in May and June would take until December to be graded on existing machines. Kiwifruit are an oval shape and are easily damaged. These needs forced the development of new solutions and faster grading speeds.

The advent of computers for rapid calculation of readings of individual fruit produced a range of ingenious solutions that could measure more than just diameter or weight.

Each fruit or vegetable had special characteristics that required special solutions. Once these challenges were met, manufacturers were able to export equipment to much larger markets than the relatively modest volumes handled by New Zealand producers.

2. History in Fruit Graders

The boxed item below describes early fruit graders

Roxburgh Historical Survey - 1939

On arrival at the shed the fruit goes first to the grader. In this district there are two main types of graders. The most usual type operates on the principle of two rotating parallel rollers with a gradually increasing distance between them. The fruit propelled from one end to the other by spiral rubber tubes would round the rollers ultimately comes to a place wider than its own diameter and falls into a sack or canvas lined bin placed at a suitable height for packing. In the other type of grader the fruit travels along an endless belting until its own weight trips it into its appropriate bin. Previously all this labour was done by hand, but now in all but the very smallest orchards it is performed by these mechanical graders, driven in many cases by electric motors.

Source: Survey of the Fruit-growing Industry, 1939, www.roxburgh.school.nz

In the mid 1950s, egg graders were used but speed nor accuracy was not their greatest asset with volumes of only 100 to 200 trays per day (0.5 tonnes). To quote a passage from Roly Earp's book 'The Kiwifruit Adventure', these machines *"looked and performed rather like a child's playground. Fruit was poured in, a field case at a time, and in due course arrived back in filled cases sorted into size groups... a laborious business."*

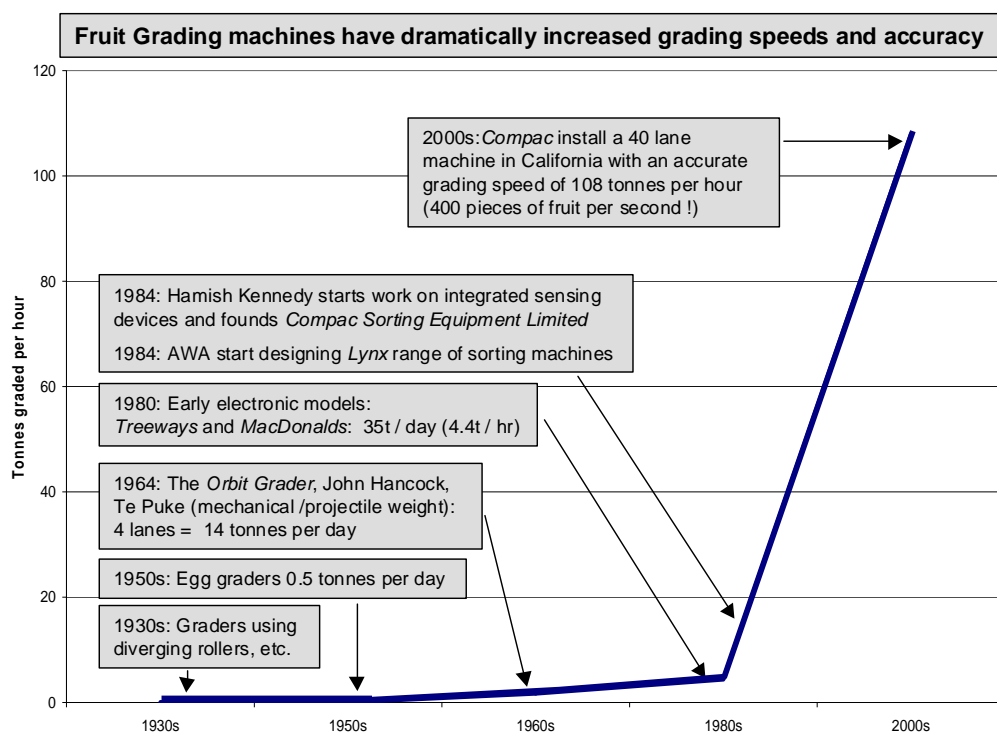
In 1964, John Hancock at Te Puke designed the *Orbit Grader* that became the mainstay of kiwifruit grading for nearly twenty years with well over one hundred *Orbit Graders* being built. Some were exported to Australia, California, and even China – the home of the 'Chinese Gooseberry.' This is a fascinating story of ingenuity from a New Zealand workshop – see separate feature story at Appendix One. When phased out in the early 1980s, many *Orbit Graders* were exported to Chile for their industry. The *Orbit Grader* was also used successfully to grade mandarins, avocados, pears, tomatoes, oranges, grapefruit and tamarillos (tree tomatoes). A four-lane *Orbit Grader* could accurately grade up to 14 tonnes of kiwifruit in an 8 hour production day.

From the early 1980s, two makes of fruit grader dominated the kiwifruit market: *Treeways* and *MacDonalds*. Both were made in New Zealand and incorporated an American design

which had been developed for the apple industry. These machines had the advantage of high output, but low accuracy. It was not until the emerging computer industry allowed 'multiple-averaging' weighing techniques to be applied to these machines that they were able to provide fast, accurate grading for the kiwifruit industry. Once a small computer was available for \$3,000, instead of \$50,000, the days of the clockwork Orbit were over. A 4-lane grader of this era could grade up to 10,000 trays per day (35 tonnes).

In 1984, AWA at Porirua commenced work on their Lynx graders as did Hamish Kennedy a graduate from Auckland University who founded Compac Sorting Equipment.

3. Timeline



4. Examples of New Zealand made grading equipment capability

4.1 Apples, kiwifruit, citrus, etc.

Compac Sorting Equipment, Onehunga, Auckland

- Compac describe their business as offering 'accuracy, innovation and technology in high quality top performing grading machines'.
- Each lane of Compac's '*In-Vision 9000*' system
 - can process 10 to 12 fruit per second, and up to 15 per second for some fruit types, such as plums.
 - takes 20 to 30 images of each fruit and stitch together as an integrated image, covering the full 100% of the surface area,
 - recognises whether a small blemish is the same or different from a previous one, and also recognising both stem and calyx as not being blemishes – all at the rate of 10 per second.

[At this speed a reader might think that impact damage must occur somewhere. Compac engineers developed a patented dual side tipping system. If two fruit are destined for the same drop, the computer determines the best side to tip each fruit to eliminate nose-to-tail collisions.]

- In one Compac system at Maricopa, south of Bakersfield, USA, a single facility uses 40 lanes of Compac machines to grade and sort Clementines at the rate of 240 bins per hour each of 450 kg / 5,000 fruit. This equates to 1.2 million pieces of fruit sorted per hour- [now that is amazing!!]
- In California, Compac have a client with four 5-lane machines (total of 20 lanes) each processing fruit at 10 per second per lane. Unique about this machine is that it sorts fruit by size, by colour, by sweetness - to 50 packing destinations. [Compac have supplied one machine that has 60 destinations]
- As part of the process, fruit passing down each lane can have one of up to up to four different labels applied to fruit.

Lynx Horticultural Systems, Albany, Auckland

- Design and manufacture fruit sizing and grading equipment using NZ Technology including Cameras designed and built by Lynx – colour spectrometer type; “*as fruit passes under reading units, it is rotated and the colour of the fruit is read eight times giving a reading surface percentage of over 95%*”

4.2 Graders for small berry fruits

BBC Technologies: located at Ohaupo, near Hamilton

- BBC Technologies lead in the field. Design work started in 1997, and with some assistance from Technology New Zealand (a TBG grant to help with design costs – but only 17% of the full design cost) first exports took place in year 2000.
- In its first five years, this company exported over 180 machines. The following describes two of their models.

BBC Technologies *Advanced Color Sorta*

- To achieve good looking fruit with above average keeping qualities, packers of small berryfruits have historically sorted and packed by hand. What BBC Technologies set out to achieve was a machine that could recognise different fruit qualities by colour and at high speed. This prospect was seen as being of huge benefit to high volume packers.
- BBC's *Advanced Color Sorta* uses colour sensing technology that is capable of sorting all types and various combinations of colours. Separation of fruit is done by air jets. Each lane on each machine can process small 2 gm fruit, for example blueberries, at the rate of 100 kg per hour. A single 72 lane/1.23 m wide machine can process 7,200 kg per hour. Larger objects, e.g. 8 gm each, can be sorted at 200 kg per lane per hour – or over 14.4 tonnes per hour for the 72 lane model.
- *BBC Advanced Color Sorta* machines have successfully processed a wide variety of fruit and nuts, including: blueberries, cranberries, olives, strawberries, cherries, cherry and grape tomatoes, peanuts, almonds and pistachios.

BBC Technologies *Soft Berry Sorta*

- A machine for sorting soft berry fruits has been a dream for many packers. Soft fruit cannot be reliably selected by colour and often only detected as soft by the touch of a hand. This process is very slow and potentially damaging to the fruit.
- To detect softness, BBC Technologies, assisted by a TBG grant, have developed a sensor technology that generates a sine wave from the contact that a berry makes as it falls at a glancing blow on a small sensor. There is a strong correlation between the shape of the sine wave and the softness of the fruit. Removal of the soft fruit is done by air jets.
- Launched in mid 2004, 20 units were expected to be sold in its first year of production.

4.3 Asparagus

Oraka Technologies – located at Cambridge

- Asparagus are generally regarded as a difficult crop to grade but Oraka Technologies have succeeded in grading to an accuracy of diameter to within 1 mm and bunch weights to within 5 percent.
- Used in countries with high labour costs such as USA and Australia, and in countries with low labour cost such as Mexico, Peru, and the Philippines.
- Critical feature is image recognition by colour: ability to measure size, colour, shape and surface features; in the case of asparagus, at the rate of 12 spears per second. In central California, they have supplied a five-lane machine that can process 5 tonnes of asparagus per hour.
- Established in 1993, Oraka have sold about 60 graders in 10 countries with their system being applicable to carrots, pineapples and other crops.
- Oraka say they need a wide range of skills including electronics, optics, optoelectronics, computer, software, industrial robotics, mechanical and agricultural skills.

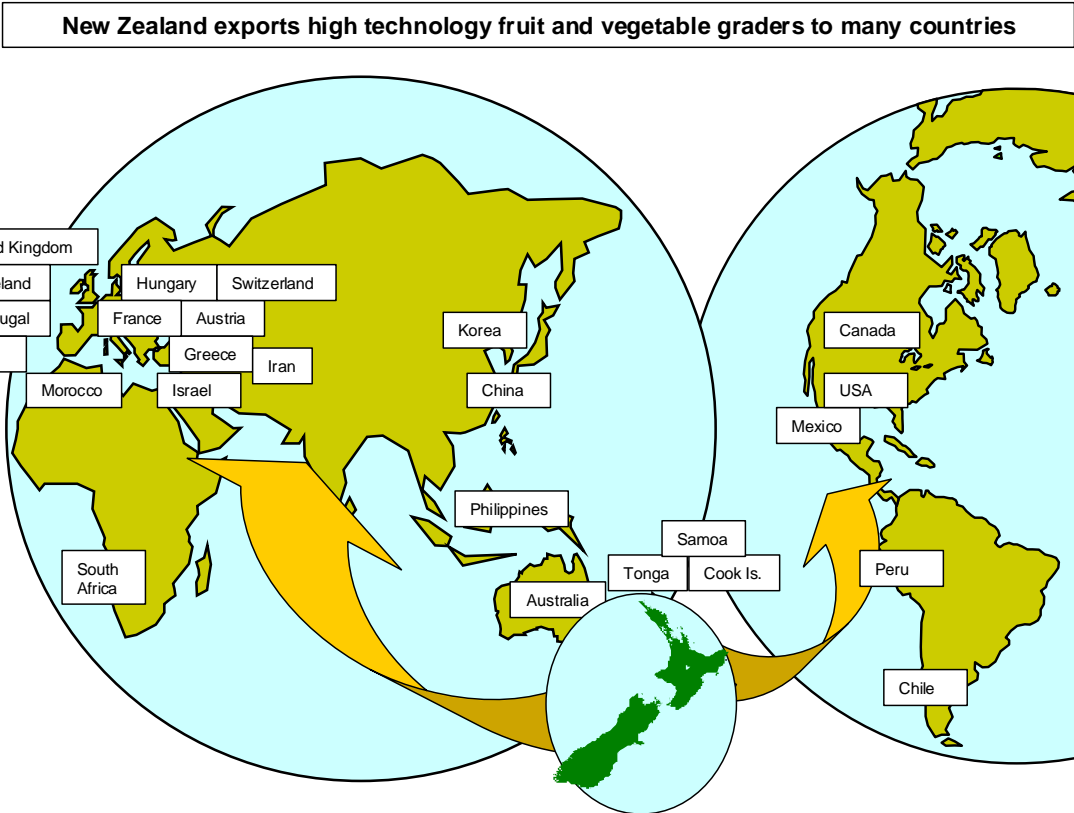
4.4 Vegetables

Wyma Engineering (NZ) Ltd – located at Hornby, Christchurch

- This business started in the 1970s repairing farm implements and grading machines. In 2001 WYMA turnover was \$2.5 million and staff numbered 18. In 2004 turnover was \$8 million and staff totalled nearly 60.
- 70% of sales going offshore with sales to eight other countries including Canada where WYMA's largest installation has capacity to process 12 tonnes of carrots per hour, and Queensland where its largest installation can process 15 tonnes of potatoes per hour.
- Feature product is its 'WYMA Vege –Polisher' for processing carrots potatoes and parsnips. This machine has a rotary barrel or drum with 14 brushes that rotate independently. WYMA have sold 50 such machines with 95% going offshore to Europe, Canada and US.

[In electronic fruit and vegetable grading equipment, WYMA work in co-operation with Compac]

5. Performance and market share



Compac

- Compac first exported their machines to France in 1991 and now say that they lead the world in optical sorting of fruit.
- More than 40% of Washington State, USA, apple production is processed on Compac machines and colour sorting system upgrades to existing graders.
[Washington State apple production is 80 to 90 million bushels (cases of 18 kg / 40 lbs capacity) i.e. about 1.5 m tons - about three times New Zealand's total apple production.]
- In California, Compac have more than 50% market share of new grading machine sales and processing citrus, tomatoes and summerfruit.

Lynx Horticultural Systems

- 60% of production sold offshore including to Australia, South Africa where a 10-lane Lynx machine grades apples, pears, plums, stonefruit on the one plant, Canada for grading stonefruit, and in USA in Oregon State, the largest pears crop in USA, where Lynx machines dominate.

BBC Technologies

- BBC Technologies who specialise in grading equipment for small berries such as blueberries, believe they now sell 80% of new berryfruit sorting machines sold in the USA.
- Since starting to export in 2000, BBC have sold over 180 machines – but only one each to New Zealand and Australia as most operations are relatively small volumes in these markets.

Oraka Technologies

- Oraka Technologies located at Cambridge claim to be world leader in machinery for grading asparagus and have been using computerised cameras since 1993.

Wyma Engineering (NZ) Ltd

- WYMA say they are the “industry leader in produce handling machinery and manufacture a large range of equipment from washers and driers to sorting tables and sizers.”
- When interviewed in August 2004, WYMA were then building a Carrot Wash Line for export to Switzerland.

Case Study Cameos – Compac

Sun Pacific, Exeter, California

This is the site of Compac's largest installation with a 40 lanes grader the size of a football field in an installation of 10 acres. It is capable of recognising, weighing and grading over 1.4 million pieces of fruit per hour (or 400 per second).

Bob Reniers, Managing Director of Sun Pacific

“... we looked at three competitors sizers. It was a perception that they (Compac) were just a few steps ahead of the competition. ... (our purchase was) the result of using their equipment, getting to know their people and being satisfied at every step. We're very happy and continuing to buy more equipment from them.”

6. What was it that helped set standards for NZ producers?

We asked the equipment designers and manufacturers to guide us as to Why New Zealand is so effective at producing these world leading machines for grading fruit and vegetables

- James Flocchini, Marketing Manager, Compac on ‘our original business driver’

“we needed to have a step up in order for New Zealand's fruit to travel all that way (to Northern Hemisphere markets) with higher transport costs to be competitive in the market – and among the things we could do was a more consistent job in sizing, a more consistent job in colour sorting – so that the product was more consistent and more easy to sell”

20 Years ago, Red Delicious apples were colour graded into two colour bands. Later one colour standard was set, with a minimum level. *[Compac optical sorting machines can grade fruit to 16 different user-defined colours.]*

Subsequently, single desk Producer Boards were able to require higher quality standards e.g. where accuracy in weight needed a standard deviation of less than one gram (0.8 gm / u.). A greater accuracy in meeting set weights per carton unit, allowed growers using Compac sorting machines to increase returns by up to 5% through not having to overfill cartons with fruit they would not be paid for. *[With the Compac system, the weight of each fruit is recorded 250 times and analysed to 0.1 grams - all in less than 1/10th of a second.]*

Next goal is to achieve dominance in Europe for sales of grading machines handling citrus, apples and stonefruit.

- Hayden Borrie, Designer, WYMA Engineering, Christchurch, exporters of produce handling machinery:

“In Canada we have a client where we have replaced equipment that is only about three years old, but technology that NZ would regard as 20 years out of date.”

- Des Langdon, Managing Director of Langdon Engineering fruit handling equipment since 1985 under the LENZ brand, located at Te Puke:

“16a (Zespri Gold® kiwifruit) required fruit handling to be so gentle, and that knowledge has now gone to ‘green kiwifruit’ also. Any of the European companies don’t compete with us (New Zealand) in this area. The fruit is handled with kid gloves, and the speed has got faster and faster. That is the trick of the game.”

- Warren Evans, Director, Lynx Horticultural Systems,

“New Zealand leads the way in what we do. We do in New Zealand what others have not even thought of. We are thinking about what to do next – up to five years ahead of where other countries have got to.”

Q. Why is this so?

“Because we are an export country. Groups like Zespri have done us all a great favour. Their insistence of quality in the market place is the benchmark. Customers (competitors in other countries) buy Zespri product in some instances just to see the quality and consistency for themselves..

By focussing on quality, this has pulled manufacturers into chasing that... our premium products are the benchmark.

We have been working to tolerances within 1 % weight variation for 15 years. By contrast, up to a couple of years ago, Canada were still using metals rings for sizing and picked fruit into baskets – both practices New Zealand did away with 25 years ago. The concept of ‘count sizes’ (fruit graded to a uniform size to fit a defined number snugly into a single tray carton) was new to producers in other countries.

When we went to sell our machines in South Africa in 2002, they did not know what colour recognition machines were, whereas in New Zealand these had been accepted as the norm and the most economic way to go.”

7. Market outlook

Compac, the largest of the grading equipment suppliers interviewed said they expected

- Their sales turnover could double in next 5 years.
- Technology will move toward increasingly advanced optics e.g. seed counts in fruit.
- Compac believe their technologies are now ahead of their time as they continue to develop capabilities that will accurately grade and sort for taste.
- Compac see a prospect for an over production of fruit. This is likely to result in increasing market demands e.g. a minimum level of sweetness (measured by brix level) but

currently there is a producer reluctance globally to sell on this basis because of the expectation that a significant portion of outputs will not meet required levels.

8. Authors' comments

- New Zealand has a long history of developing accurate fruit and vegetable grading equipment.
- Coordinated selling and a commitment to achieving optimum quality outturn of fruit and vegetables in distant markets has led to the development of grading machines that now lead the world in a number of produce types.
- New Zealand exporters' demands for the highest quality possible in distant market places for sometimes fragile produce has been a valuable environment in which to develop leading-edge systems and high technology solutions.
- At the formative stages, a number of companies had benefited from research funding support. In each instance, the amount has been relatively small and only part of the development costs involved. The funding has however been important as it was received at a time when there was no revenue from the development still in progress. All recipients were complementary about the value of such support.
- The continuing drive for faster and better systems has been a major contributor in keeping export produce competitive. In the early 1980s it cost \$2.65 for grading, packing and the packaging of one tray of kiwifruit. In 2004, the costs for grading, packing, packaging AND the fruit and on-orchard costs of one tray was \$2.50 per tray. Reduced on-orchard costs from the Zespri System of integrated fruit production, orchard management and logistics has helped, but so too has the very high speed automated grading systems where bins are automatically emptied at one end of a packing facility and completed trays come out the other in perfect condition.
- There is merit in recognising the value of knowledge wave type thinking and resources being applied to New Zealand's advanced horticulture industries where New Zealand has proven market leadership. As one equipment manufacturer told us, their small company had to bring together a wide range of skills including those in electronics, optics, optoelectronics, computer, software, industrial robotics, mechanical engineering and agricultural. All of these skills were available in New Zealand – and at a world-class level.
- The combined export values of the small number of companies cited in this study is over \$40 million annually – and commentators said there are a number of other companies also exporting equipment and systems for processing fresh produce.
- If *Compac Sorting Equipment's* projection for market growth is valid, and *WYMA Engineering's* growth from \$2.5 million to \$8 million in four years suggests it may well be, then New Zealand could be exporting around \$100 million in produce grading and handling equipment before 2010.

Sources of information

'*The Kiwifruit Adventure*', Roly Earp, Dunmaore Press, 1988

'*Celebrating 100 Years – The New Zealand Kiwifruit Industry 1904 – 2004*', Zespri Group Limited, 2004

Various media including Fiona Rotherham article in Unlimited 1 April 2004.

Interviews:

Historical background:

- Peter Berry, Zespri
- John Hancock, Tauranga (developer of the *Orbit Grader*).

Compac Sorting Equipment Ltd www.compacsort.com

- David Buys, Executive Director
- Karen Lawton, adviser to Compac Sorting Equipment Ltd

BBC Technologies www.bbctechnologies.co.nz

- Greg Furniss: owner and principal:
- Brad Thomson: Operations Manager:

Oraka Technologies www.oraka.co.nz

- Rob Schwarz

Wyma Engineering (NZ) Ltd www.wymaengineering.co.nz

- Hayden Borrie, Designer

Langdon Engineering www.packhousegear.com

- Des Langdon, Managing Director

Lynx Horticultural Systems www.lynxhort.co.nz

- Warren Evans, Director (interview)

Attachments to this case study

Note: in preparing the foregoing case study the authors also collected profiles of the above companies and recorded these as seven Attachments covering 18 pages, including the 'The Orbit Grader Story', and intended for closer detail by persons investigating the same subjects.

This case study is one of a 21-part case study series aimed at demonstrating the value of science and innovation in New Zealand's leading edge bio-science industries... and their significance to New Zealand.

Martech Consulting Group is a strategic consultancy based in New Zealand. The growingfutures case study series was in part based upon Martech's extensive work with sector representative groups, science providers and organisations that interact with science providers to achieve consensus on co-ordinated actions, improve governance, develop sector-based strategies and improve innovation processes.

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