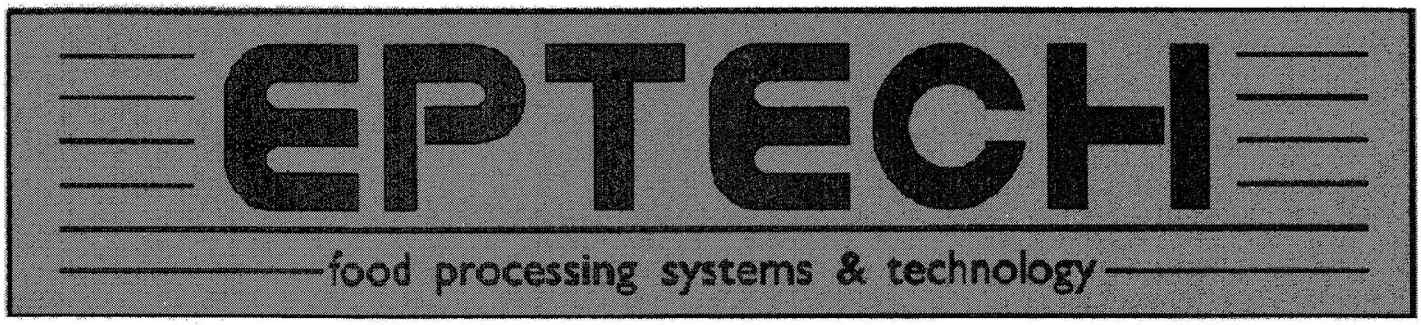


Supporting document

Author:	Rudolf de Haan
Coach:	Anton Honders
Graduation direction:	Technical Commercial Engineering
Company name:	Eptech
Location company:	Paarl, South Africa
Period internship:	August 2005 - January 2006

KEY TECHNOLOGY

APPLICATION ESTIMATION REPORT

Reported by Jeroen Erinkveld

DATE	10-09-05	**MACHINE:**	Optyx 3755
PRODUCT:	Macadamia Nuts	**FUNCTION:**	Performance evaluation
CUSTOMER:	**SAD** Evergreen **SAD** Lowveld Nuts	**LOCATION:**	Witrivier
CONTACT:	Giepie Schreuder	**TELEPHOME:**	+27 **13 733 3030** +27 **82 909 5897**
E-MAIL:	gschreud@pioneerfoods.co.za	**WEBPAGE:**	www.pioneerfoods.co.za
FAX:	+27 73 **733 4178**	**JOB NUMBER:**	N/A
VIDEO:	**None**	**PHOTO:**	**Yes**

Purpose of test/demo:

SAD needs advice on type of sorting machine and what its capacity will be.

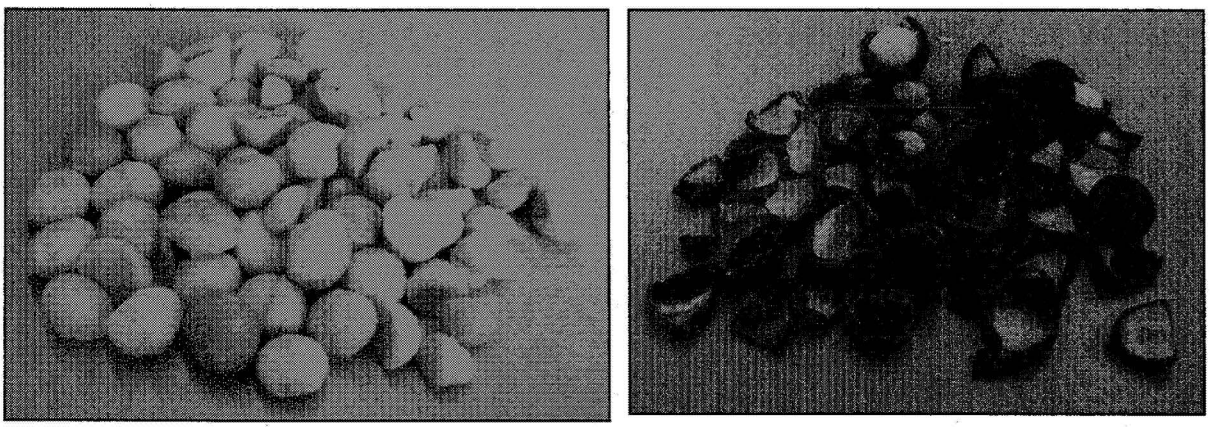
Application:

Product Information:	
Product:	Macadamia nuts
Product color:	Light yellow
Product size (L – W – H) (mm)	20x20x15 mm
Condition:	Dry
Requested capacity: (kg/hr)	2000 kg/hr
Weight per 100 pieces: (g)	203 grams
Incoming defect percentage: (%)	+60%
Environment temperature: (°C)	?

Defect Information:		
Name defect 1:	**Size (Ø in mm):**	**Color:**
• Pieces of shell	• 25mm	• Dark brown
Name defect 2:	**Size (Ø in mm):**	**Color:**
• Whole nuts	• 25mm round	• Dark brown

Procedure:

1. **Product & defect photos:**



Picture 1: Sample – Good product and defects.

2. Capacity calculation/estimation:

With 3000 kg/hr on a belt with of 610mm running 2,44 m/s: The belt has a maximum belt load to still have acceptable performance. Take in account that the defect load is very high to reduce yield toss ejection need to be done with 1 ejector and with minimal duration. This will have affect on the defect removal.

With 2000 kg/hr on a belt of 610 mm running 2,44 m/s: The product could Rave better individual product space. This will be better for the removal of defect and yield loss.

Still performance will not be optimal if defect load will not be reduced.
Since shells are bigger than the nut it might be a solution to grade out object bigger than 20mm in diameter. This way higher capacities and better performances can be expected.

3. Recommended machine configuration:

Optyx	
Product:	Macadamia nuts
Optyx configuration:	3755 – two color cameras. *Some of the shells are same color as good product from one site.*
Cameras:	Two color cameras. Defect and good product color are easy to distinguish.
Lamps:	HID
Belt Style:	White nubbin belt
Air assist:	At in-feed end required
Side Guide:	Standard side guide
Acceleration chutes:	Required
Accept/Reject chutes:	Standard
Product stabilizer:	None
Ejector plate:	Standard
In-feed shaker:	Standard in-feed shaker, but with option to remove oversized.
KeyWare:	Standard Color 2.01
Comments:	

5. Recommended follow up:

- A performance test needs to be done with a larger sample. To really know the removal and capacity.
- A shaker test needs to be done to see if it is possible to reduce defect laad.

Conclusion:

It seems to k a n easy application.
Results will be better when we reduce defect load.

APPLICATION TEST REPORT

Reported by Jeroen Erinkveld

DATE:	12-Clctober-2005	**MACHINE:**	Optyx 3755
PRODUCT:	Macadamia nuts	**FUNCTION:**	Performance test
CUSTOMER:	SAD Evergreen/Lowveld Nuts Zetnuts, Levubu	**LOCATION:**	Worcester , South Afrika
CONTACT:	• Giepie Schreuder, Operational Manager • Johan Vos Manager	**E-MAIL:**	gschreud@pioneerfoods.co.za
TELEPHONE	+27 23 348 5220	**FAX:**	+27 23 347 3666
WEBPAGE:	www.sadfoods.co.za	**JOB NUMBER:**	
VIDEO:	No	**PHOTO:**	yes

Background:

Tests need to be done on the Optyx 3755 to determine the performance of both applications. Separating shells from nuts was done before with water, but this appears not to be good for the quality of the nut. **SAD** is looking fora dry method to sort the shells from the nuts.

Application:

Product Information:		
	Application 1	Application 2
Product:	Macadamia nuts	Macadamia nuts
Product color:	Light yellow	Light yellow
Product size:	5mm – 15mm	5mm – 15mm
Condition:	Dry	Dry
Requested capacity: (kg/hr)	1500 kg/hr	As high as possible
Bulk density: (kg/m³)		
Pieces per 1 kg: **Weight per 100 pieces: (g)**		
Incoming defect percentage: (%)	10% - Industrial defects 5% - shells	10% - Industrial defects 65% - shells
Environment temperature: (°C)		

Defect Information:		
Name Defect1:	**Size (Ø in mm):**	**Color:**
• Industrial defects	• >4mm	• These are the nuts that contain spots that are black, brown, gray or white in color.
Name Defect2:	**Size (Ø in mm):**	**Color:**
• Shells	• >4-15mm	• The shells are one side completely brown. The other side can be dark brown or product color.

Equipment used:

Optyx		
Type:	Optyx 3755	
Camera	Top: Color camera	Bottom: Color camera
Normalization:	White normalization target	White normalization target
Belt:	Blue belt with nubbins	
KeyWare	Standard Color 2.01	
In-feed	Standard in-feed shaker with Perforated decks	

Procedure:

Test product was taken with me from South Africa.
For Application 2 (75% defect load) I had a sample of 5kg.
For Application 1 (15% defect load) I could make one total sample of 1kg.
The disadvantage of having such a smal sample (1 kg) was that product gets damaged after a couple runs.

Results:

Application 1:

CALCULATIONS		Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Average
% Total defect removed		68,27%	77,55%	94,82%	92,44%	74,56%	82,35%	90,07%	83%
% Good product loss	F/(F+D)*100%	0,67%	4,93%	14,68%	4,33%	0,73%	1,69%	2,84%	4%
% Good product in reject	F/(F+G)*100%	7,79%	31,16%	51,82%	25,88%	5,73%	11,19%	15,53%	21%
Bad:Good	1:.....	0,08	0,45	1,08	0,35	0,06	0,13	0,18	0,3327
Good:Bad	1:.....	11,83	2,21	0,93	2,89	16,46	7,93	5,44	6,8146
Removed defect 1	Shells	98,0%	100,0%	100,0%	100,0%	92,7%	97,3%	100,0%	98%
Removed defect 2	Industrial	41,8%	62,6%	91,2%	86,6%	54,4%	66,2%	80,5%	69%
Incoming Defect	(E+G) / A * 100%	11,61%	14,03%	14,39%	13,55%	16,04%	16,25%	17,15%	15%
Defect in Good	E / (E+D) * 100%	3,58%	3,21%	0,87%	1,06%	3,95%	2,83%	1,72%	2%
Load Rate (kg/hr.)		806	1.048	1.256	1.437	1.239	1.883	1.723	1341
Remarks:	Sliders								
Results:	Defect 1	20	10	10	20	20	15	15	
	Defect 2								
	Other	100	100	100	100	100	100	100	
	duration	955 / 147	955 / 147	955 / 147	955 / 147	955 / 147	955 / 147	955 / 147	
	delay	30 / 30	30 / 30	30 / 30	30 / 30	30 / 30	30 / 30	30 / 30	
	# puffers	3 / 3	3 / 3	3 / 3	3 / 3	1 / 1	1 / 1	1 / 1	
	Pressure	50	50	50	50	50	50	80	

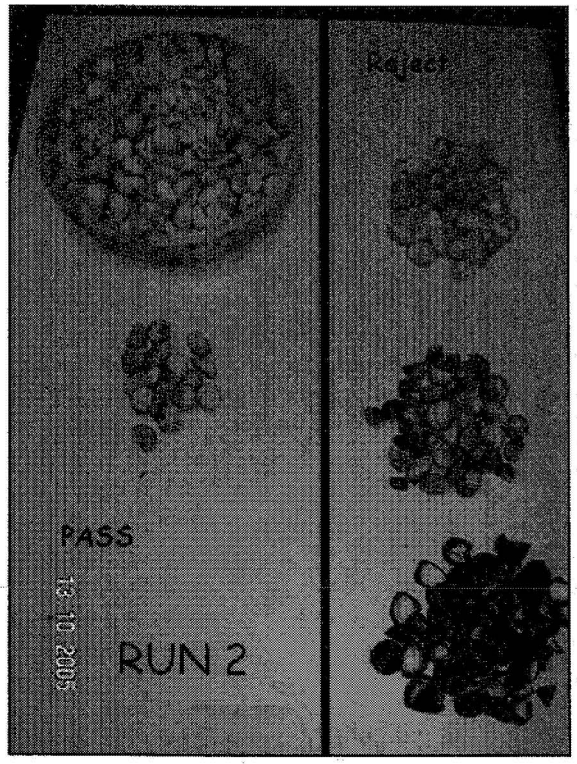
A number of runs where done to find the best settings for the machine in software setup as well as in mechanical setup.
Industrial defects could be divided in two classes since some contact small defect and other has obvious defects. The bigger defects are removed more efficiency than defects that are a lot smaller.

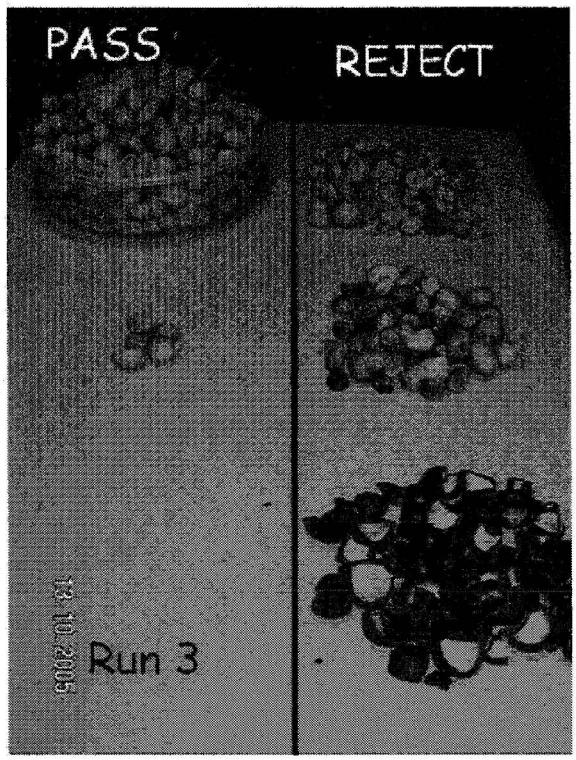
Note: Performances are measured in weight. One piece of shell is much lighter in weight than a nut. Performances of good to bad ration in reject will look much better if performance will be done in count. The choice is made to do measurements by weight, because it is less time consuming.

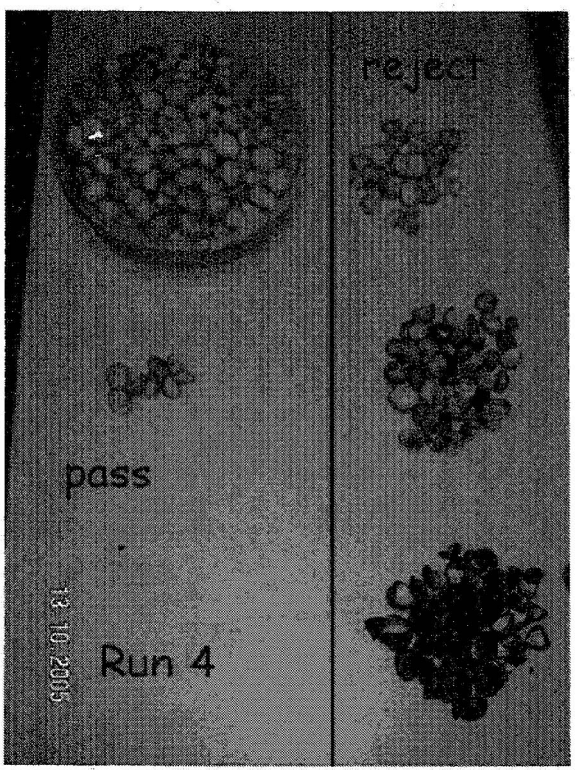
Performance Estimation

Defect Removal Percentage		Good to Bad ratio in reject
Critical defects	93% – 98%	1 : 5
Major defects	65% – 70%	
Broken Shells	94 – 99%	

Defect description	
Critical defects	All nuts with white, brown or black discoloration > Ø 8mm.
Major defects	All nuts with white, brown or black discoloration > Ø 4mm.
Broken Shells	All pieces of shell with on one end a chocolate brown color and on the other end a cream yellow color or dark brown color. > Ø 5mm.







Top left: The results of **Run** *2, left are the good product and defect that are found in the pass bin and right are the good product and defects found in the reject bin.*

Top right: The results of Run 3, left are the good product and defect that are found in the pass bin and right are the good product and defects found in the reject bin.

Left: the results of Run 4, left are the good product and defect that are found in the pass bin and right are the good product and defects found in the reject bin.

Application 2

The last setting was used from the previous testing since the best results are recorded with that setting,
Our standard in-feed shaker did not allow running at very slow capacities.
Suggested is a shaker that runs at a normal speed, so product will be spread better. A wider shaker is recommended.

RUN 1

	PASS
Good product	293
Industrial	15
Shell	14
	REJECT
Good product	30
Industrial	39
Shell	599

Total	990
Time	4
Capacity	891
REMOVAL	
Industrial	72%
Shell	98%
G : B	1 : 21

2nd PASS

	PASS
Good product	274
Industrial	8,5
Shell	0
	REJECT
Good product	11
Industrial	14
Shell	14

Total	321,5
Time	2
Capacity	578,7
REMOVAL	
Industrial	62%
Shell	100%
G : B	1 : 3

2nd REJECT

	PASS
Good product	
Industrial	56
Shell	27,5
	REJECT
Good product	
Industrial	11
Shell	55

Total	149,5
Time	3
Capacity	179,4
REMOVAL	
Industrial	16%
Shell	67%
G : B	1 : 5

To clean a product with a very high defects load requires most of the times double sorting.
Since the removal rate of the sorting machine does not improve much with lowering the capacity.
The removal rate will also not be much better or worse with high defect loads, but if you have a high defect load your good to bad ratio of the reject looks relatively good but you percentage of defects in pass stream is higher. Sorting the pass stream a second time will bring the results to more acceptable levels.

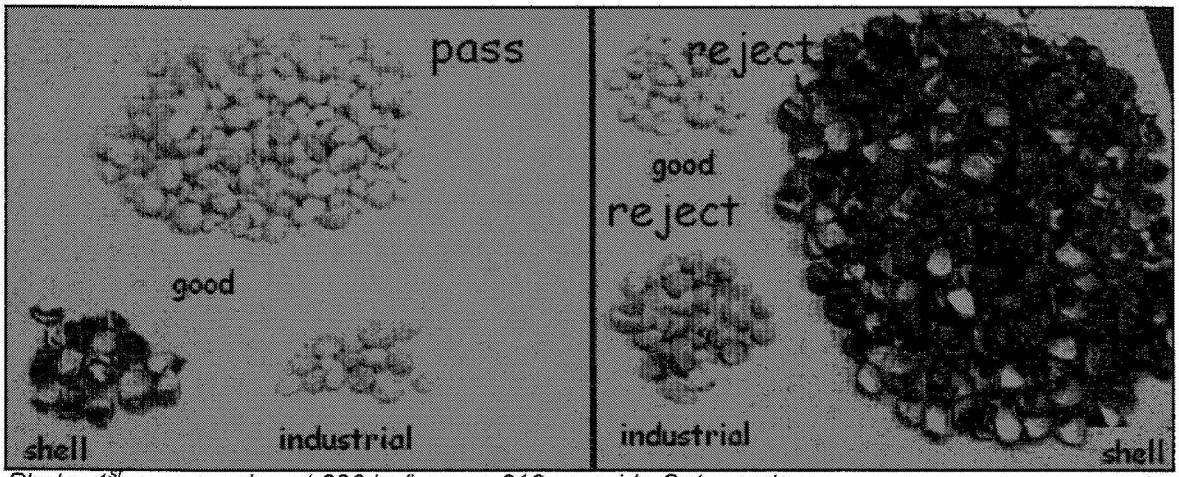


Photo: 1st pass running at 890 kg/hr on a 610mm wide Optyx sorter.

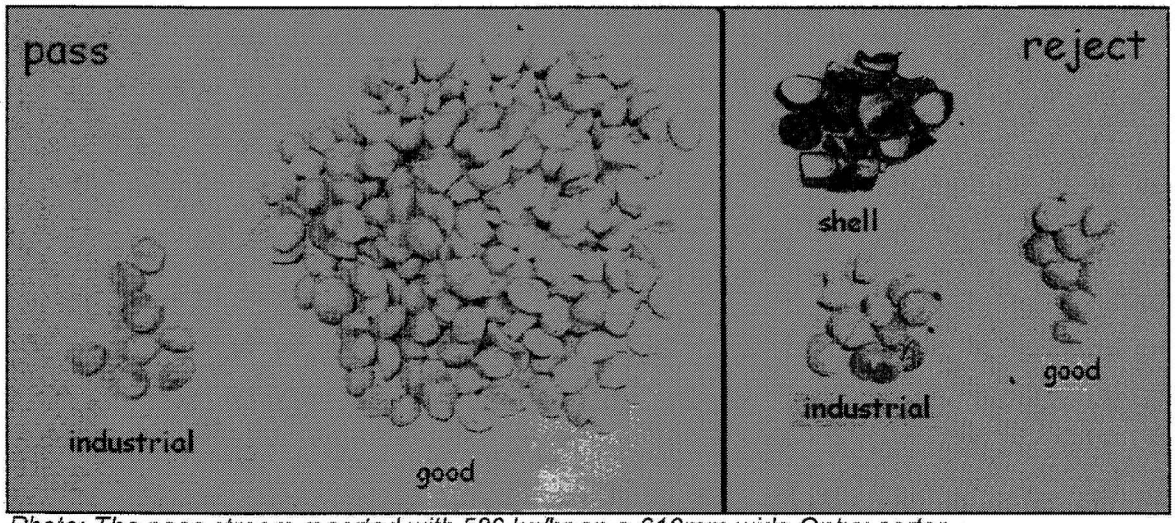


Photo: The pass stream resorted with 580 kg/hr on a 610mm wide Optyx sorter.

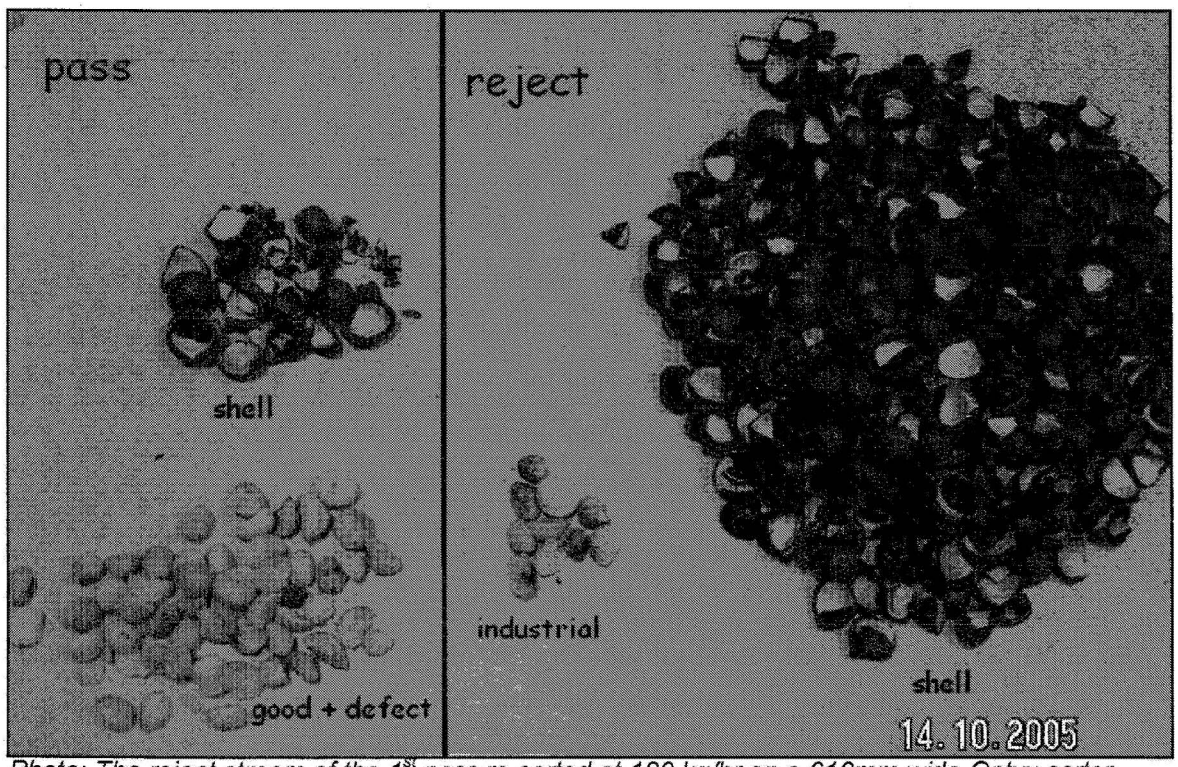


Photo: The reject stream of the 1st pass re-sorted at 180 kg/hr on a 610mm wide Optyx sorter.

Note: In weight it might be the case that defects are 75%, but in count it is much more than that, since pieces of shell weigh much less than a nut.
Performance can be improved when the product is graded first, removing the small partials. When looking to image above you can see that most defects that are missed are the very small ones.

Recommended machine configuration for new installation:

Optyx™		
Product:	Application 1 (15% defects)	Application 2 (75% defects)
Optyx configuration:	3755	3755 or 6755
Cameras:	Standard color cameras	Standard color cameras
Lamps:	Standard HID	Standard HID
Belt Style:	Blue nubbin belt	Blue nubbin belt
Air assist:	Not required	Not required
Side Guide:	Standard	Standard
Acceleration chutes:	Standard	Standard
Accept/Reject chutes:	Standard	Standard
Product stabilizer:	Required	Required
Ejector plate:	Standard	Standard
In-feed shaker:	Standard shaker with perforated screens	Standard shaker with perforated screens adjusted with running at a low speed.
KeyWare:	Standard Color 2.81	Standard Color 2.01
Comments:		

Conclusion:

- The first application is a very good application for the Optyx; good sorting efficiencies can be expected.
- The second application need to be graded before it will go over a sorter. All small partials and complete nuts need to be removed from the product steam. Sorting the product twice will result in acceptable results. It is possible to have a doable pass on one machine, by splitting an Optyx 6755 (1220mm wide sorter) in the middle.

Applications Test Report

Report By: Ken Carambot

DATE:	July 12 – 13, 2005	MACHINE:	Optyx 3355 UHR
PRODUCT:	Dried apricots and pears	FUNCTION:	Test detectability on sub-millimeter defects.
CONTACT:	Nellis Zaaiman (Ops. Man.) and Abdul Mookadam	PHONE:	+27(023) 348-5237
CUSTOMER:	SA Dried Fruit (SAD)	LOCATION:	Worcester, South Africa
CASE NUMBER	N/A	JOB NUMBER:	N/A
MODEL:	Optyx 3355 UHR	SERIAL:	
KEYWARE USED:	Standard Color 2.01		

PURPOSE OF TEST/DEMO:

This test was performed in order to evaluate the UHR (Ultra High Resolution) equipped Optyx 3000's ability to "see" and remove dried fruit products with sub-millimeter sized defects. The products to be tested were dried apricots and pears (post washing). This post washing process leaves some very small defects and some misc. foreign material embedded in the meat of the soft-side of the fruit. The customer does plan to run both "standard" grade (slightly darker fruit) and "High" grade (premium light colored fruit) products on this machine. "Commercial" grade (darkest fruit) will not be sorted on this machine at this time. The standard-resolution Optyx (0.6mm pixel size) was not able to resolve these smaller defects in order to target them and remove them from the process. This test would also determine the capacity that the Optyx could process at these higher resolutions.

EQUIPMENT USED:

Optyx 3355 equipped with two UHR cameras on top only. The resultant pixel size for this configuration is approximately 0.17mm, with each camera scanning a 152mm (6 in.) field of view. The cameras were set to scan at 8000 scans/sec, which required the belt to be slowed down to approximately 91 m/min (300 Ft/min). Belt color of choice is the orange smooth belt (similar to #022378 in color, which is a laned belt). See photo #I below,

Since we only have a top camera UHR setup (at this time), we discussed hand-placing the product on an infeed "system" with the soft-side up. We hadn't anticipated being able to feed this product using Iso-Flo but later tests (discussed below) showed that it might be possible to feed an Optyx with a shaker (further tests are needed to ensure adequate volumes and speeds ean be achieved). Otherwise a series of belts may be needed in the following configuration: Primary belt running approximately 15 m/min (where human inspectors would verify product is face up), followed by an acceleration belt running at

approximately 30 m/min, which would then feed the Optyx belt running at 91 m/min. Testing still needs to be done to confirm either infeed system. The customer is asking that we develop and present to them the "complete solution", from infeed to discharge.

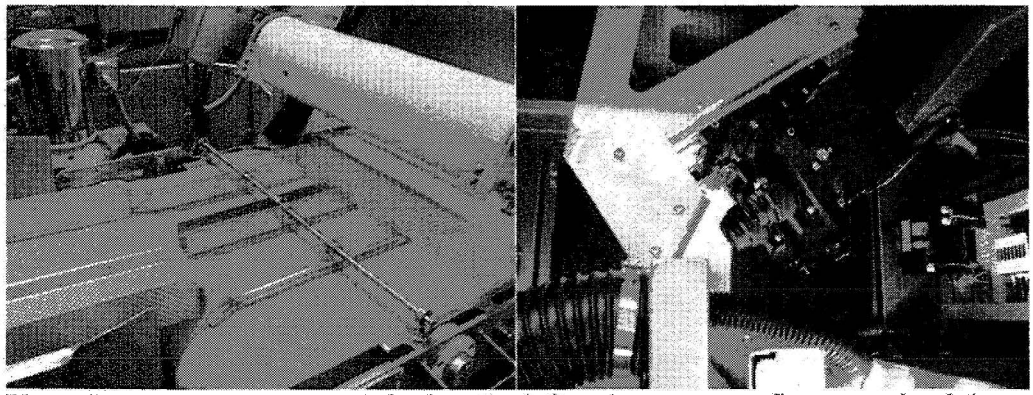


Photo #2. UHR Optyx setup. Infeed on the left and two camera fixture on the right.

RESULTS/WORK PERFORMED:

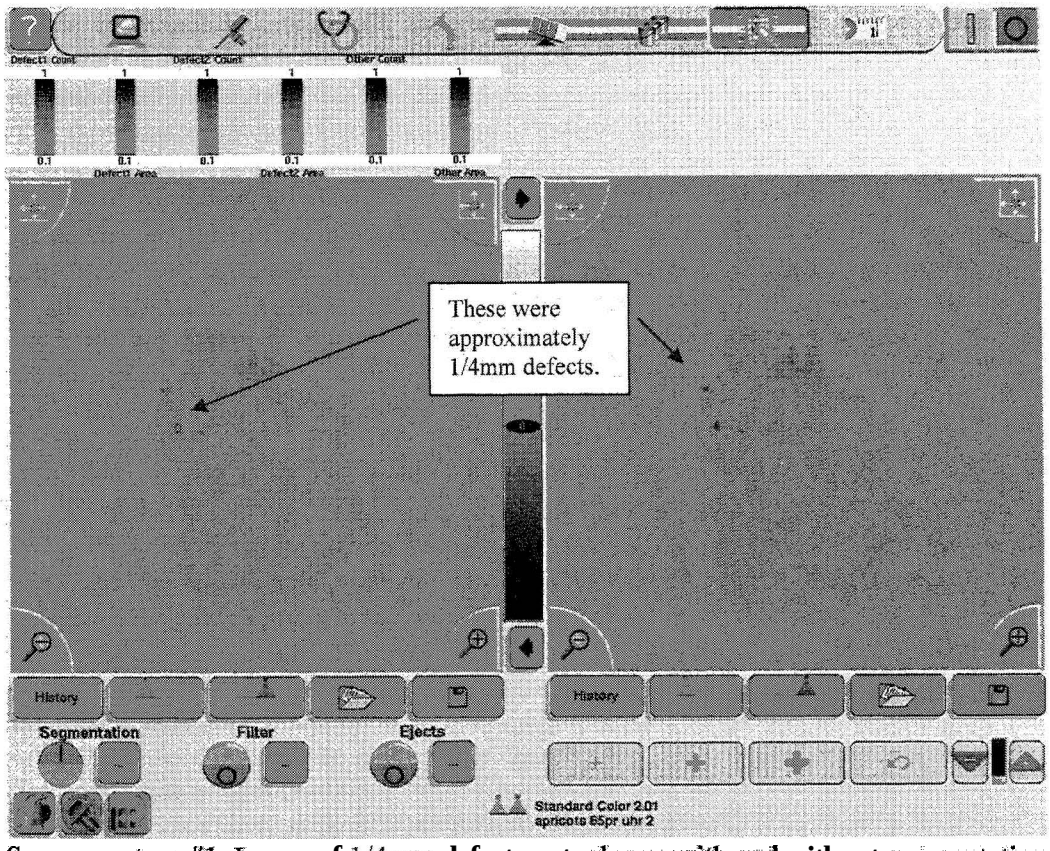
Initial tests were done using both a smooth white belt and our standard smooth blue belt. Both presented challenges to making a good sort so we switched to the orange belt. for the remainder of the tests, The technique for training colors using the orange belt is to train both background and good product to background. Since the customer is not interested in overall fruit size and only interested in defect spot size, this technique works well. On the apricots, one is able to train for both a "lighter-than" and a "darker-than" defect. On the pears, only a "darker-than" defect can be targeted due to the light colors of the meat.

Product characteristics:

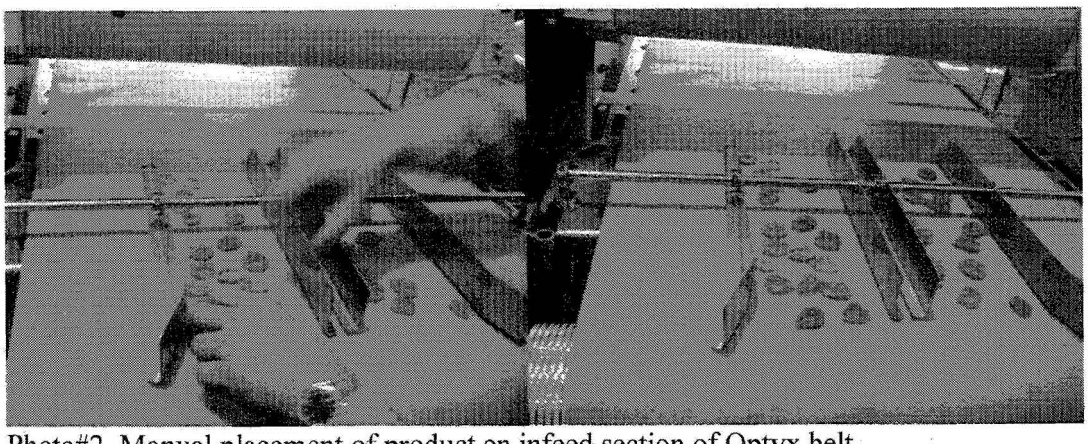
Apricots	Size: 19mm – 50 mm dia.	Condition: Dry and somewhat sticky.
Pears	Size: 50mm – 90 mm dia.	Condition: Dry and sticky,

Initial tests were conducted to determine what the smallest defect size was that this UHR setup could resolve on both products. Apricots were run first, followed by pears. With both products, if was found that the smallest defect that we could reliably resolve was 1/4mm in diameter (see Screen capture #1). If these defects have good contrast with good product colors and can be see in full view, they can be reliably detected and sorted out. It was more of an experiment to see if these defects could be seen than to implement this in actual production. Defect spots this small may normally be disregarded and allowed to pass.

Desired capacity is approximately 3 metric tons per hour. Apricot tests showed that with the existing two camera system and an appropriate feed system a maximum feed rate of 2.5 metric tons was possible. After these tests, the discussion turned to the possibility of adding a third UHR camera to cover a 457mm area versus the current 304mm. The above calculations were made based on manually loading the infeed section of the conveyor belt (see Photo #2).



Screen capture #1. Image of 1/4mm defect spots shown with and without segmentation.



Photo#2. Manual placement of product on infeed section of Optyx belt.

In addition to the testing on the Optyx, the customer was also shown how these products would run on vibratory conveyors. Both the Iso-Flo and the Impulse were discussed and demoed. A recommendation for each, if vibratory conveyors were part of the final solution, would be to implement this using 9° arm angles and higher RPM to minimize the vertical component and keep product velocities up. As proposed earlier in this report, this infeed system would need to include a conveyor that operators could stand or sit

beside to manually ensure all the product is face-up. The next phase would be to accelerate the product in preparation for transfer to the Optyx's belt, which is traveling at approximately 91 m/min (300 ft/min).

CONCLUSION:

Testing showed that the UHR camera equipped Optyx could give good results on the sub-millimeter sized defects this customer is looking for. There is also good potential to address the customer's requirements, at lower line flows, with the existing two camera setup. Higher line flows can be achieved with the addition of a third camera. Careful consideration needs to be given to the infeed "system" but we are confident that this can be developed in order to provide SAD with a complete working solution with either conveyor belts or vibratory conveyors.

The UHR camera setup we used during testing employed two 152mm viewing areas separated by a 20mm gap. Since this application only requires defect spot size recognition it would be best to develop an overlapping or "blended" viewing area and eliminate the gap between each camera. This would reduce the complexity of the required side guides considerably.

Keyware used was Standard Color 2.01, which worked very well. No other development is required here.

See additional images below.

MACHINE SETUP:

Mechanical Recommendations:

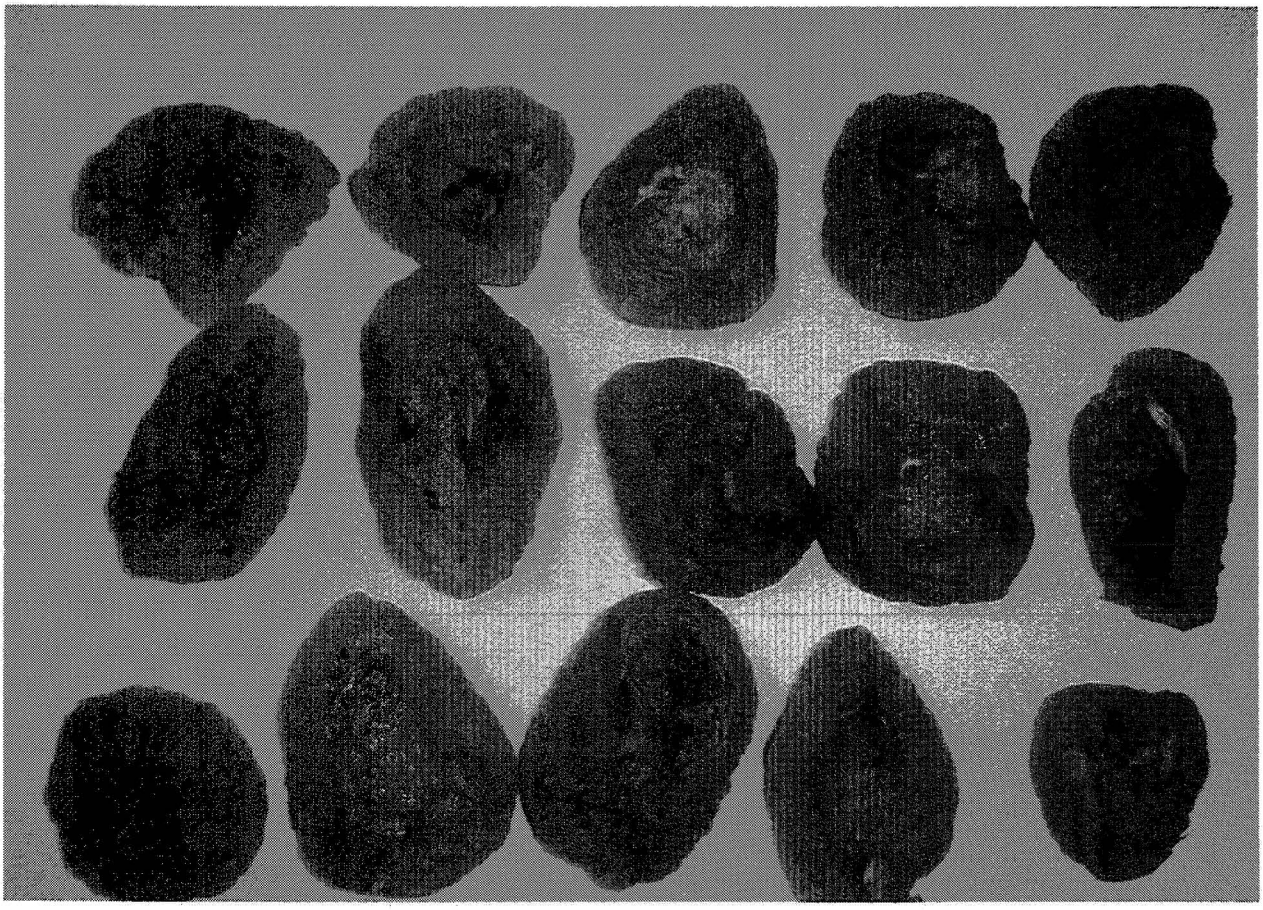
Special infeed system is required to allow manual inspectors to flip product face-up followed by an acceleration phase in order to transition to the Optyx belt. Take-away was not discussed.

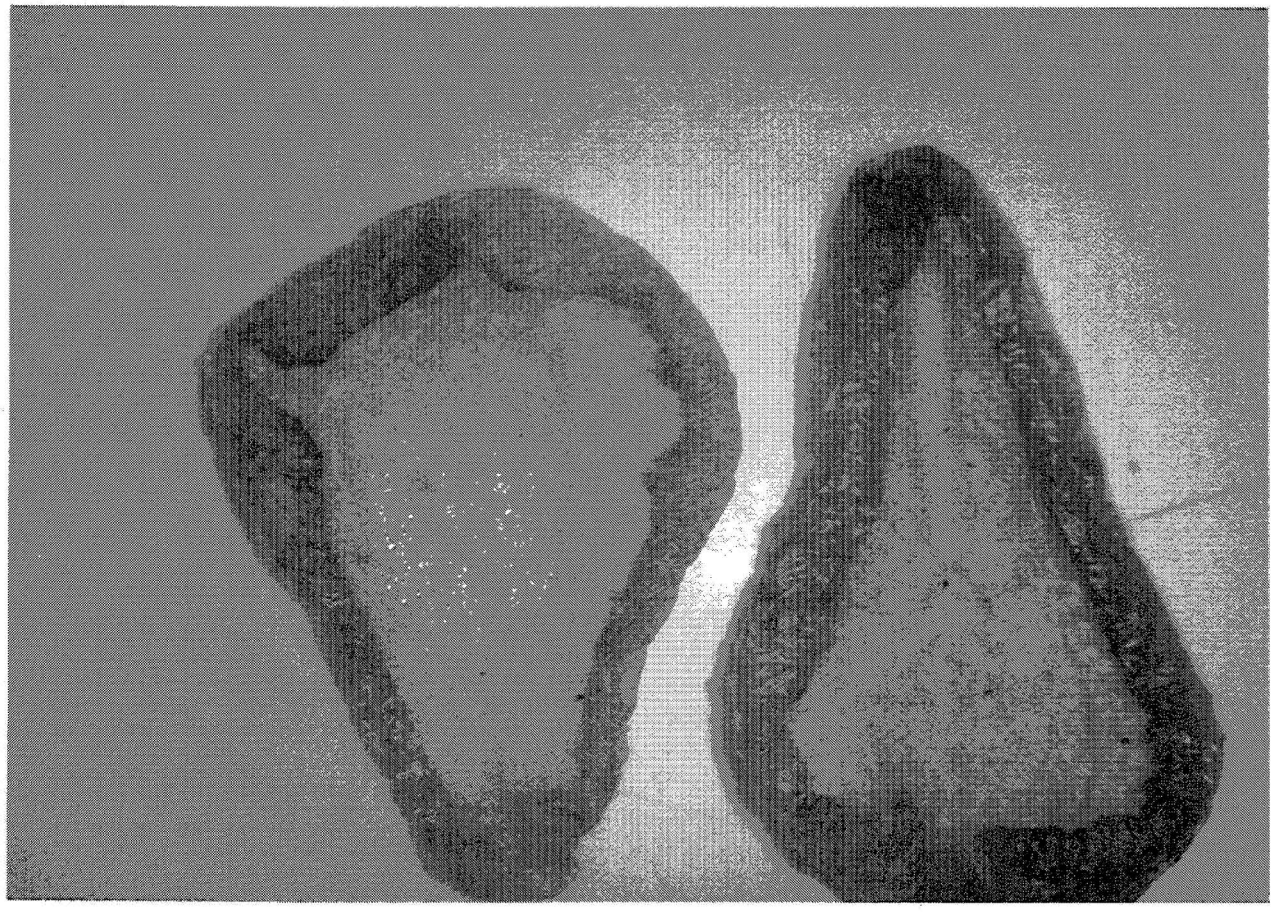
Optyx Mechanical Set-up:

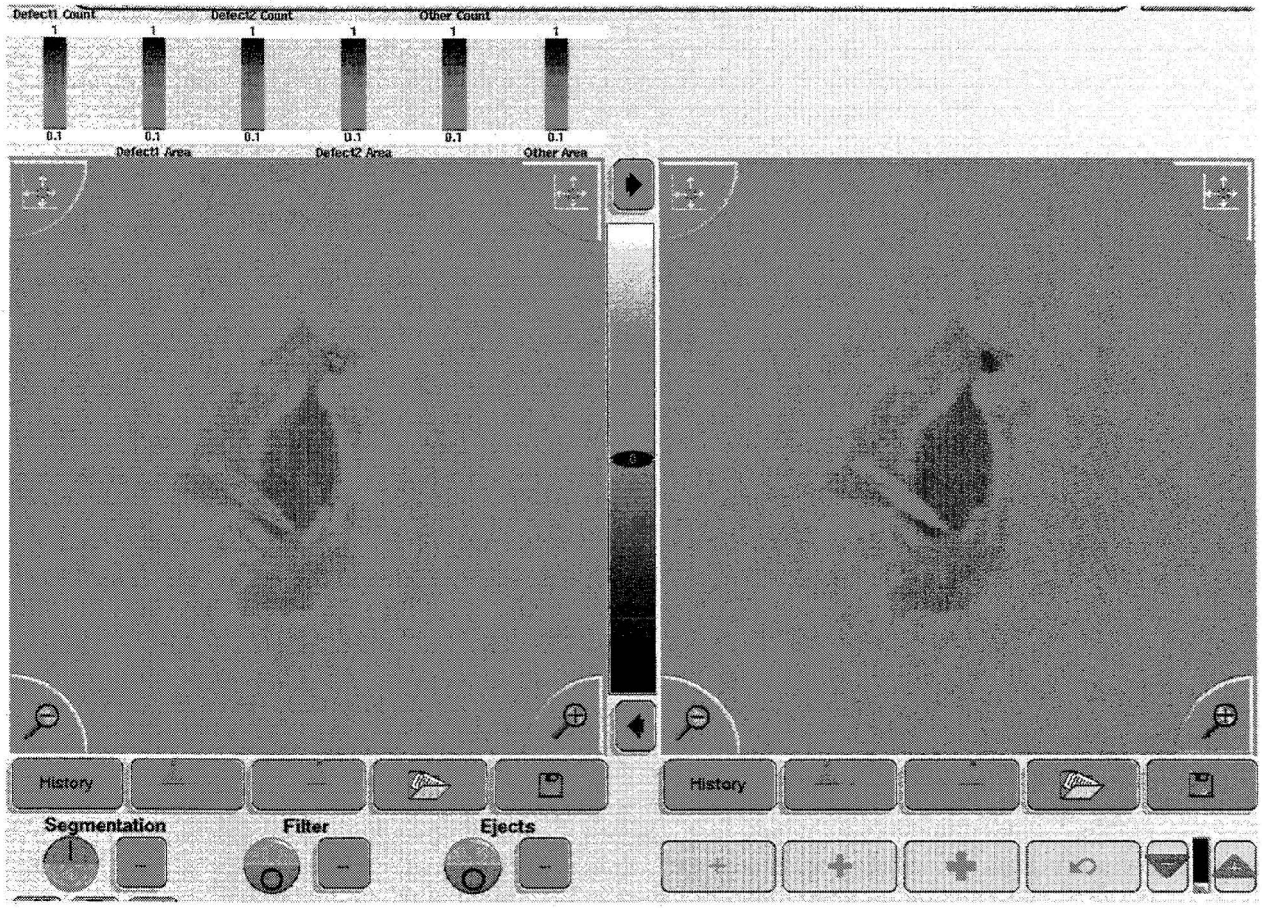
Pass Chute In/Out Position:	10 (all the way in)
Pass Chute Angle:	40
Pass Chute Height:	5.5
Ejector Height:	Lowest position possible
Ejector Manifold Plate	w/o bottom camera background
Delay / Duration/ Ejectors	Top: 2500 110013 apricots; 2500 120015 pears
Ejector Nozzle	Std.
Air Pressure	65 psi
Number of Ejectors	3 and 5
Camera Type - Top	UHR
Camera Type – Bottom	N/A
Belt Type	Orange smooth (not currently part numbered)
Laser Option	
Backiight	NIA
Illumination - Top	HID lamps
Illumination - Bottom	NIA

Norm Target - Top	Gray 65%
Norm Target - Bottom	N/A
Bottom Cam Background	N/A
Air assist – shaker	N/A
Air assist – nose bar	N/A
Product Stabilizer Reqd	No
Side guides	Custom for smaller inspection area
Misc	

PERSONS ATTENDING: Ken Carambot, Leon Louw, Quentin Kemph
Optyx OS: Build 824 with delay and durations based on actual scan rate vs. a fixed 4K scan rate.



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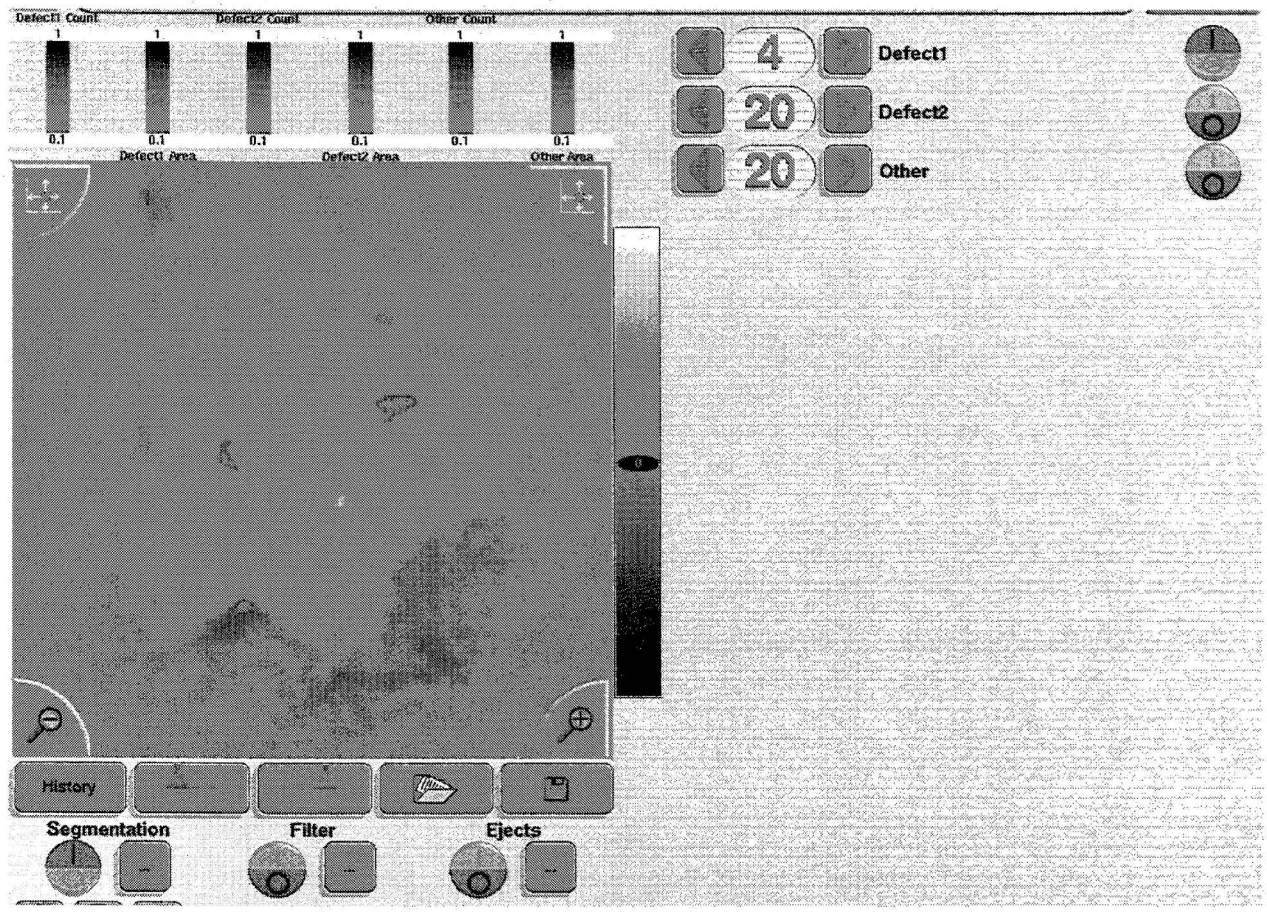
Defect2 Count
Other Count
Defect1 Area
Defect2 Area
Other Area
History
Segmentation
Filter
Ejects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Other Area
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Defect2
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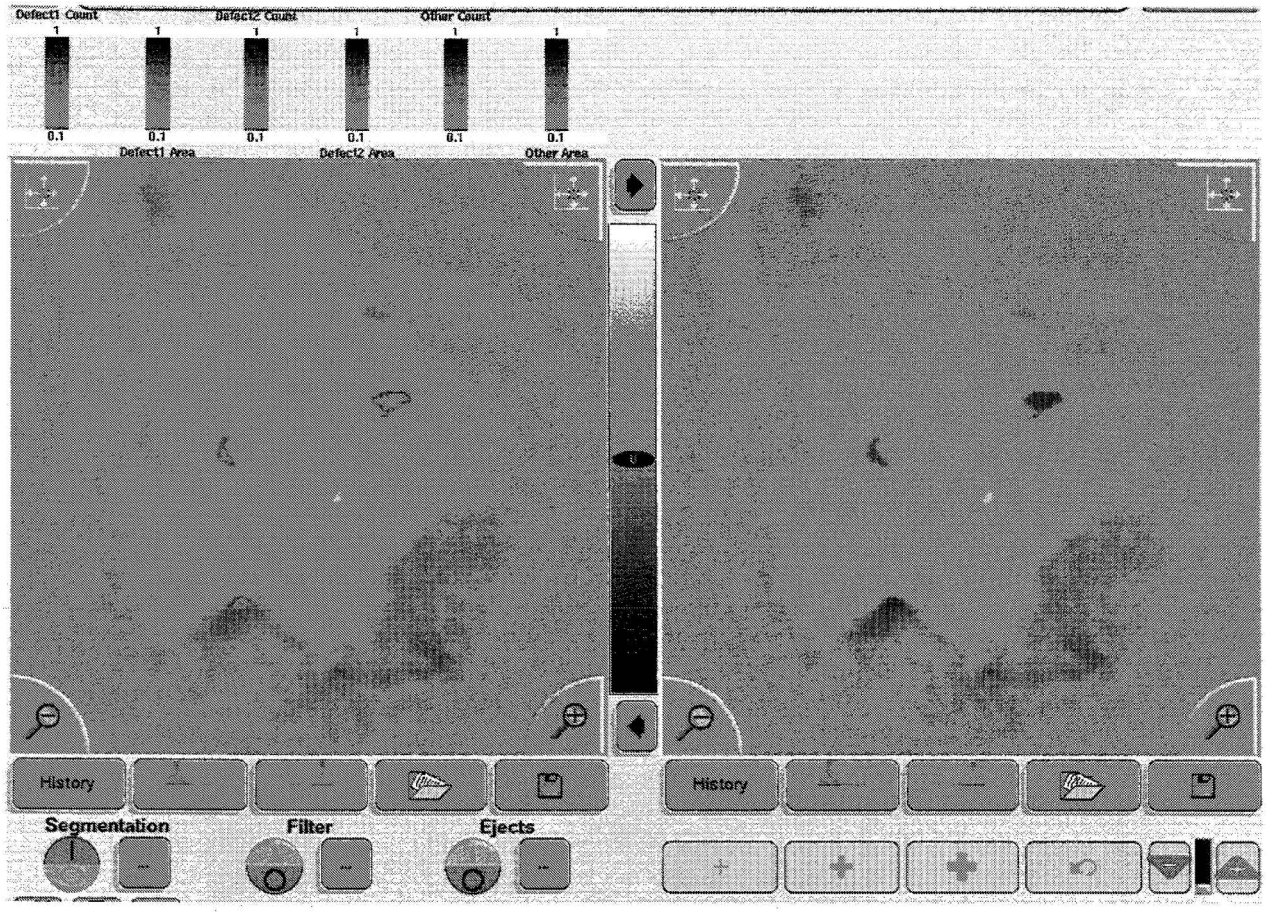
Other
History
Segmentation
Filter
Ejects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Other Count
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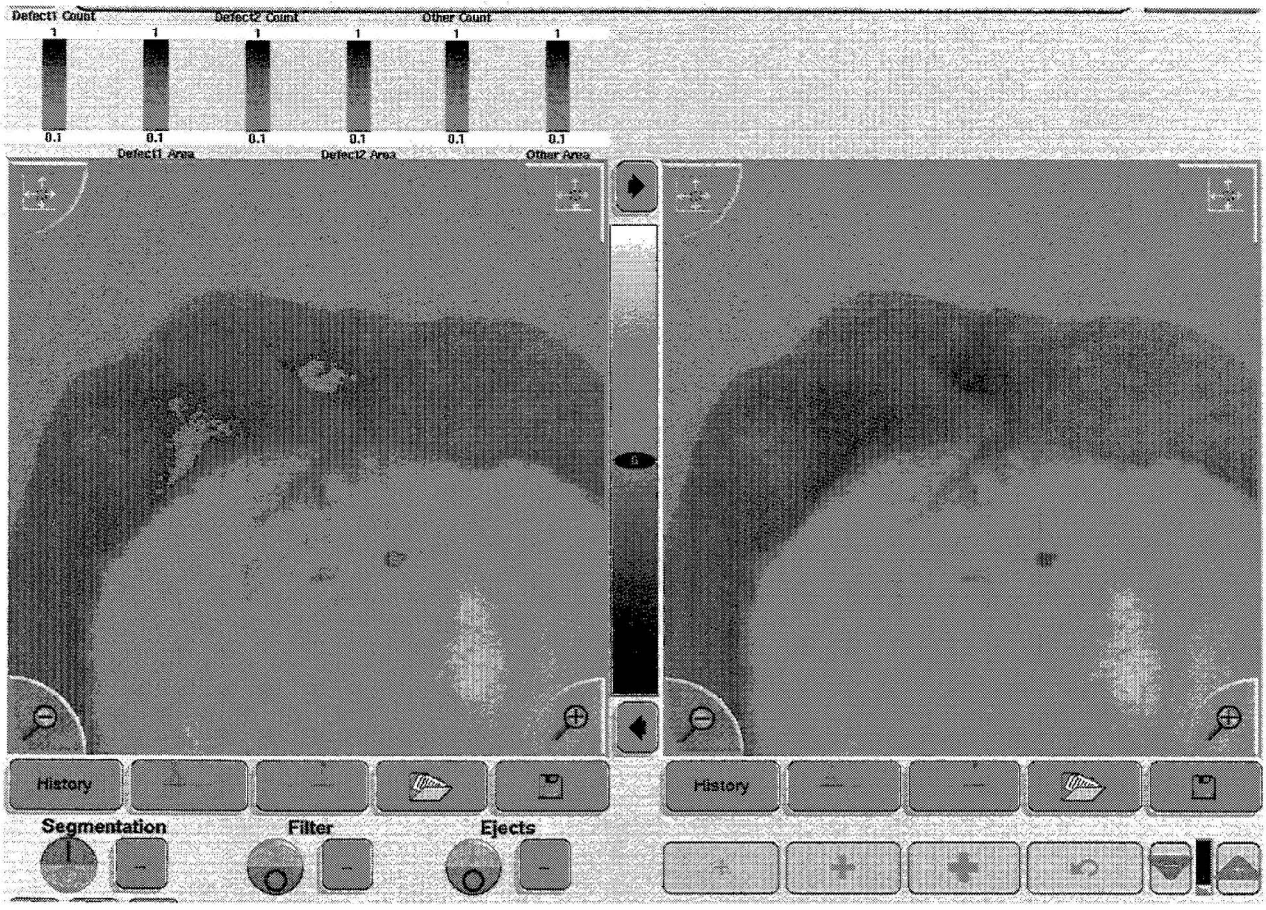
Defect2 Area
Other Area
History
Segmentation
Filter
Ejects
History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Defect2 Count
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Defect1 Area
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