

final report

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Feasibility and Pre-Production development of integrated data capture/management and product handling in beef processing

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Abstract

This report describes the first fully automated data management and product handling system. The product handling system has been installed at Kilcoy Pastoral Company in QLD. This system utilises product handling to pack and transport chilled and frozen meat cartons to various locations in a warehousing system. Data must be stored and maintained throughout the process. Data flows from the abattoir control systems and is added to pallets of product. These sets of data are tracked and maintained throughout the system to account for all cartons in the process.

Executive summary

The automation of the load out area at KPC has seen a streamlined approach to the back end of the abattoir.

The system is a flexible way to move product through the loading area and can adapt to periods of chilled, frozen or mixed out feed.

The system is currently being operated by the staff at KPC and is handling the entirety of the product that is being sent to the room.

The product flow to the room has been changed since the projects beginning with the line being fed frozen and chilled product in separate shifts rather than at the same time. This limits the system throughput.

Data seamlessly flows from the KPC sortation system to the Handling system and is handed back to the warehousing system at the end of the process.

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1 Project objectives

The overall objective of the project is to demonstrate a production ready prototype and proof of concept for carton/pallet handling, sortation and delivery.

The specific project objectives have been:

- Design, develop, install and commission an integrated and automated product transfer system for pallet handling.
- Integrate pallet handling with the automated palletising system and KPC cold storage facility.
- Provide a fully automated and integrated pallet handling solution direct from the palletising room and delivery of completed pallets to individual cold storage locations.
- Provide KPC production and process advantages over traditional palletising and pallet handling solutions as listed.
- Undertaken industry open days and producer education days.
- Provide KPC post installation training and production support.
- Develop a post installation cost benefit analysis and dissemination video and report.

This project is the first step in a wider fully integrated and automated material handling approach to improve efficiencies, operator safety, traceability and reduced labour at KPC. This project will also develop skills and capabilities in KPC to cost effectively evaluate ideas to proof of concept.

2 Discussion

2.1 Overview of System operation

As can be seen from the layout image below the new palletising system consists of 4 robot cells each fed by 4 infeed conveyors. Each of these infeed conveyors can be assigned a separate SKU and hence 16 different SKUs can be palletised at any one time. Cartons are diverted onto each of these infeed conveyors off the main ring conveyor according to their SKU (read by barcode scanning cameras located on the main ring). The robots palletise each of these SKU's and the full pallets are removed from the pallet stand and transported through a Pallet Barcode Scanning System, a pallet wrapper, pallet labeller and then deposited at either the chiller or freezer infeed conveyors where they are removed by forklift and stored.

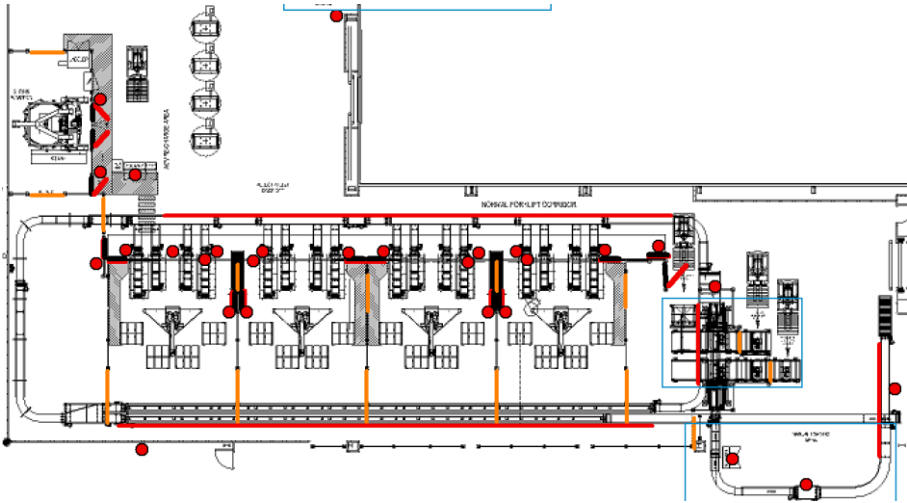


Fig. 1 Palletising System Layout



Fig. 2 Pallet stands with robot above



Fig. 3 Robot and gripper with cartons queued on infeed lanes ready for palletising



Fig. 4 Barcode scanning camera on the main ring, used to determine which infeed lane each carton should be diverted down.



Fig. 5 Divert gates used to diverted cartons off the main ring. This image shows the infeed conveyor set to receive cartons off the lower (chilled) ring conveyor.



Fig. 6 Palletised cartons waiting to be transported to Whole of Pallet Barcode Scanner.

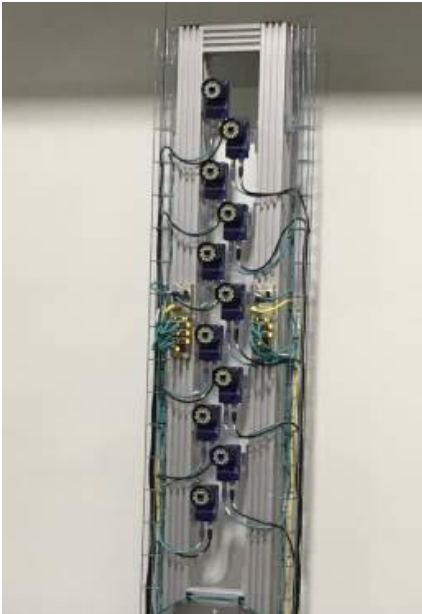


Fig. 7 Pallet Barcode Scanning System, consisting of 11 Barcode Scanning Cameras



Fig. 8 Completed pallet ready for scanning by the Pallet Barcode Scanning System



Fig. 9 Completed pallet being wrapped



Fig. 10 Wrapped pallet complete with pallet label deposited at entrance to freezer

2.2 Assignment of SKU's to lanes

The images below are screen shots of the code that interfaces with KPC's Inventory Management System (IMS). KPC operators allocate an SKU to each lane from their control room. The code in Fig. 15 shows the allocation of an SKU to each lane as received in the palletising software from the IMS. Fig. 16 shows the status of lane 1 once allocated while Fig.17 shows the lanes with SKU's allocated on the operator HMI.

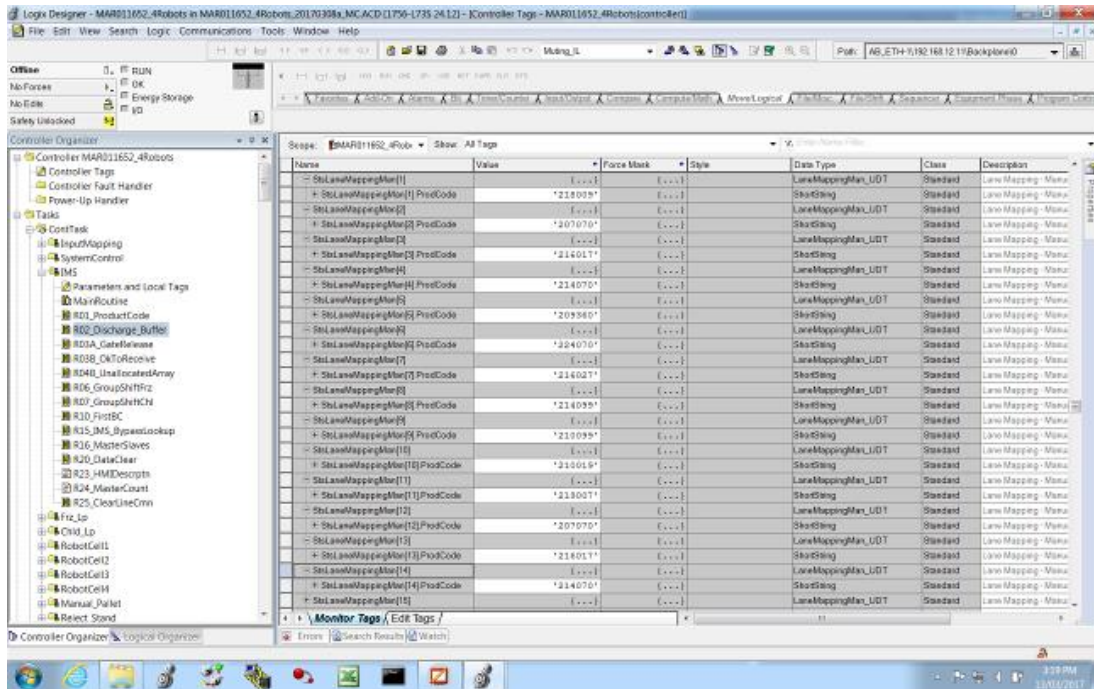


Fig. 11 Product – Lane Status (as selected from IMS)

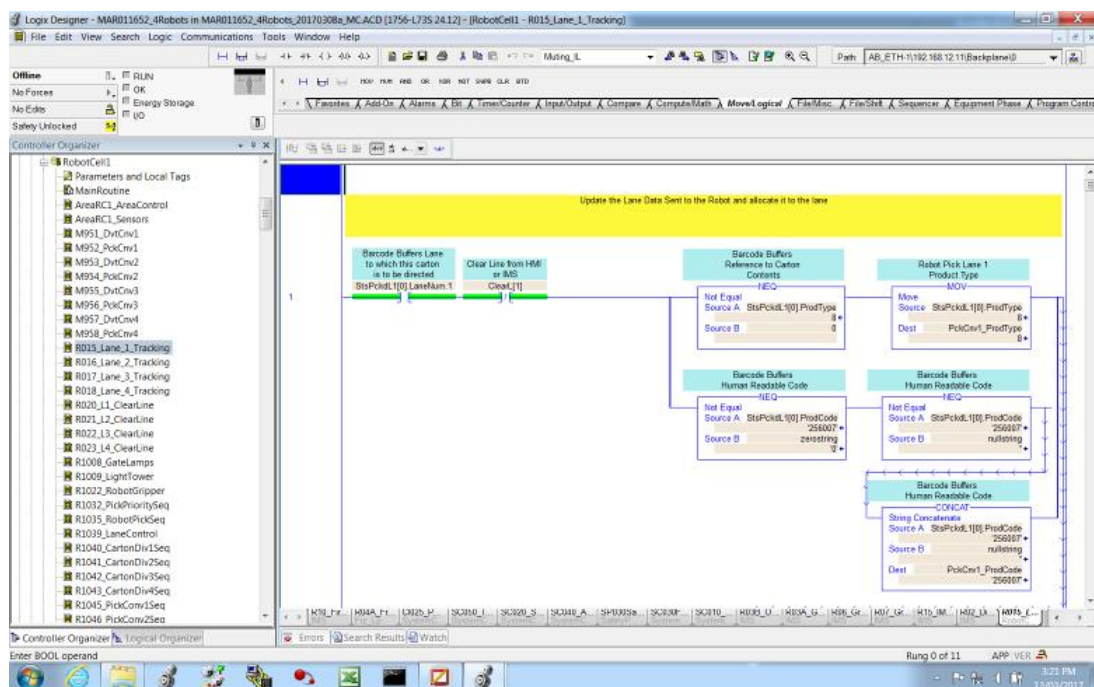


Fig. 12 Lane 1 Status

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LANE MAPPING
Current User: maint

GROUP # 1

| Lane No | Slave To | Sorting Key | Palet Recipe | Expected Cartons | Total Paletised | Remain | Ctr | Status |
|---------|----------|--|--------------|------------------|-----------------|--------|-----|----------------------|
| 1 | 9 | Sort K: 211047 Desc: *S-ERMP*GRAN FED MWAC HOP FREE | 5 | 0 | 0 | 0 | 0 | Allocated To Chilled |
| 2 | 10 | Sort K: JAP-Skirts Desc: | 6 | 0 | 0 | 0 | 0 | Lane Ready To Accept |
| 3 | 11 | Sort K: 236044 Desc: *S*FORESHIN GRAIN FED MWAC | 5 | 0 | 0 | 0 | 0 | Allocated To Chilled |
| 4 | 12 | Sort K: 214065 Desc: AGED HOP *S*STRIPLOIN | 8 | 0 | 0 | 0 | 0 | Allocated To Chilled |
| 5 | 13 | Sort K: 236045 Desc: *S*HINDSHANK GRAIN FED MWAC | 5 | 0 | 0 | 0 | 0 | Allocated To Chilled |
| 6 | 14 | Sort K: 224065 Desc: *S*CUBE ROLL GRAIN FED MWAC | 9 | 0 | 0 | 0 | 0 | Allocated To Chilled |
| 7 | 15 | Sort K: 209169 Desc: *S-RMPC* GRAIN FED MWAC HOP FREE | 5 | 0 | 0 | 0 | 0 | Allocated To Chilled |
| 8 | 0 | Sort K: Desc: | 0 | 0 | 0 | 0 | 0 | Lane Ready To Accept |
| 9 | 9 | Sort K: 211047 Desc: *S-ERMP*GRAN FED MWAC HOP FREE | 5 | 137 | 9 | 911 | 0 | Allocated To Chilled |
| 10 | 10 | Sort K: JAP-Skirts Desc: | 6 | 129 | 0 | 309 | 0 | Lane Ready To Accept |
| 11 | 11 | Sort K: 236044 Desc: *S*FORESHIN GRAIN FED MWAC | 5 | 163 | 12 | 361 | 0 | Allocated To Chilled |
| 12 | 12 | Sort K: 214065 Desc: AGED HOP *S*STRIPLOIN | 8 | 266 | 21 | 245 | 0 | Allocated To Chilled |
| 13 | 13 | Sort K: 236045 Desc: *S*HINDSHANK GRAIN FED MWAC | 5 | 189 | 18 | 742 | 0 | Allocated To Chilled |
| 14 | 14 | Sort K: 224065 Desc: *S*CUBE ROLL GRAIN FED MWAC | 9 | 138 | 12 | 158 | 0 | Allocated To Chilled |
| 15 | 15 | Sort K: 209169 Desc: *S-RMPC* GRAIN FED MWAC HOP FREE | 5 | 65 | 3 | 204 | 0 | Allocated To Chilled |
| 16 | 0 | Sort K: Desc: | 0 | 0 | 0 | 0 | 0 | Lane Ready To Accept |

Frozen Height Check Enable Chilled Height Check Enable

Back Overview Frozen PR Chilled PR Frozen Loop Chilled Loop Man. Palet Robot Cell 1 Robot Cell 2 Robot Cell 3 Robot Cell 4 PR Drop

Fig. 13 SKU's allocated to each lane as shown on the operator HMI

2.3 Scanning of completed pallets, data verification and transfer to IMS

During the building of a pallet the robot system builds a data array of all the barcodes that are on the pallet. Once a full pallet of cartons has been palletised the pallet is transported to the Pallet Barcode Scanning (PBS) System . At this point the data array is copied to the PBS System and the pallet is rotated a full 360 degrees in front of an array of barcode scanning cameras (Video attached as an appendix to this report). The PBS System scans the barcodes and compares what it has been detected to the array that arrived with the pallet. If

- all the barcodes match, a 'Pass' signal is sent to the Palletising System PLC and the PLC transfers the data array to the KPC IMS along with a pallet number and the pallet is cleared to travel through to the wrapper and labeller. At the labeller a label is printed containing the relevant pallet number.
- the barcodes don't match a 'Fail' signal is sent to the Palletising System PLC and no information is sent to the KPC IMS System. The pallet is cleared to travel through the wrapper (without wrapping) and labeller and travel to the 'rework' stand where it is manually scanned and transported to the chiller or freezer as appropriate.

Below is the code used in the Palletising System PLC (Ladder Logic) and the Pallet Barcode Scanning System (Visualbasic.Net) that enables this transfer of data to occur.

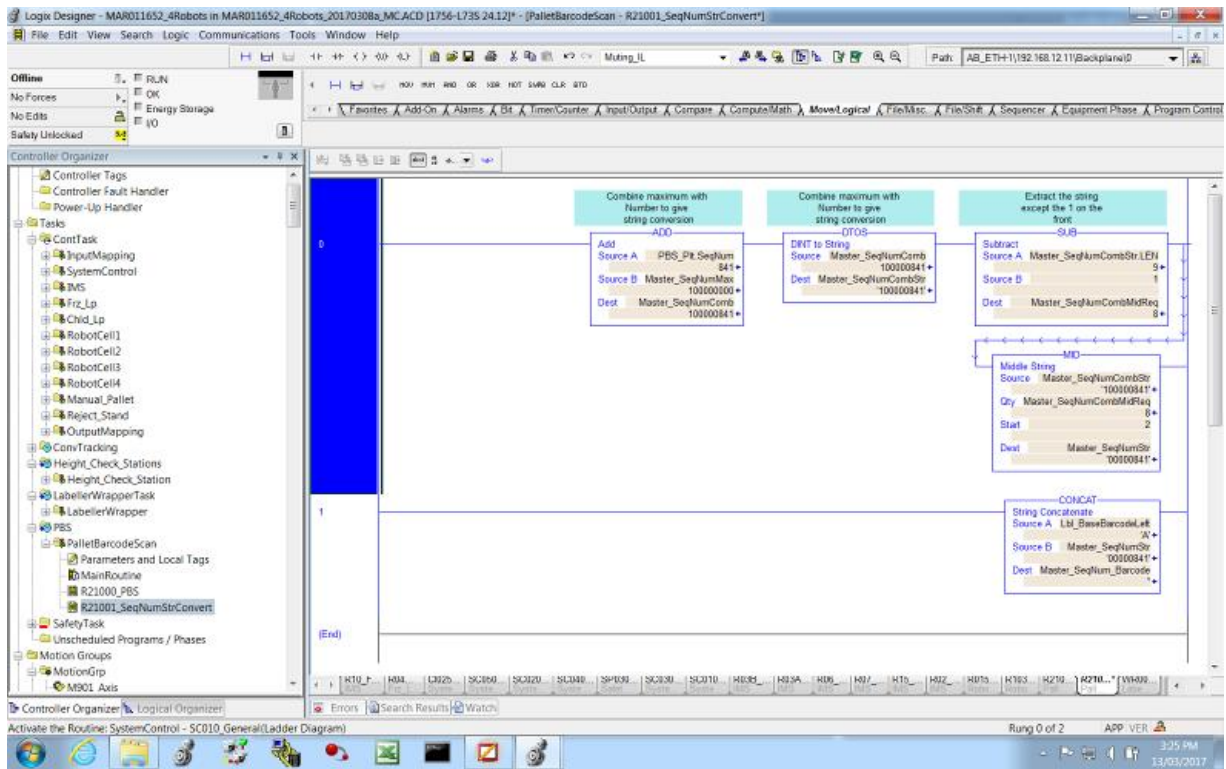


Fig. 18 Pallet Sequence Number to PBS - PLC Code

| Name | Value | Force Mask | Style | Data Type | Class | Description |
|-------------------------|----------|------------|-------|------------------|----------|------------------------|
| - AGVPi | {...} | {...} | | PalletData[20] | Standard | Pallet Data for Each A |
| + AGVPi[0] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[1] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[2] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[3] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[4] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[5] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[6] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[6] Cfm | {...} | {...} | | Barcode_LUDT[49] | Standard | Tracking Pallet Data E |
| + AGVPi[6] Date | 20170307 | | | DINT | Standard | Tracking Pallet Data E |
| + AGVPi[6] Time | 165651 | | | DINT | Standard | Tracking Pallet Data E |
| + AGVPi[6] SeqNum | 797 | | | DINT | Standard | Tracking Pallet Data E |
| + AGVPi[6] Source | 16 | | | SINT | Standard | Tracking Pallet Data F |
| + AGVPi[6] TotalCartons | 36 | | | SINT | Standard | Tracking Pallet Data F |
| + AGVPi[6] RefCode | 0 | | | SINT | Standard | Tracking Pallet Data F |
| + AGVPi[6] CfmType | 0 | | | SINT | Standard | Tracking Pallet Data F |
| + AGVPi[6] SeqNumStr | 797* | {...} | | ShortString | Standard | Tracking Pallet Data G |
| + AGVPi[7] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[8] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[9] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[10] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[11] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[12] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[13] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[14] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[15] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[16] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[17] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |
| + AGVPi[18] | {...} | {...} | | PalletData | Standard | Pallet Data for Each A |

Fig. 19 Pallet Cartons on pallet – showing 36 cartons, date and time of robot palletising complete – PLC Code

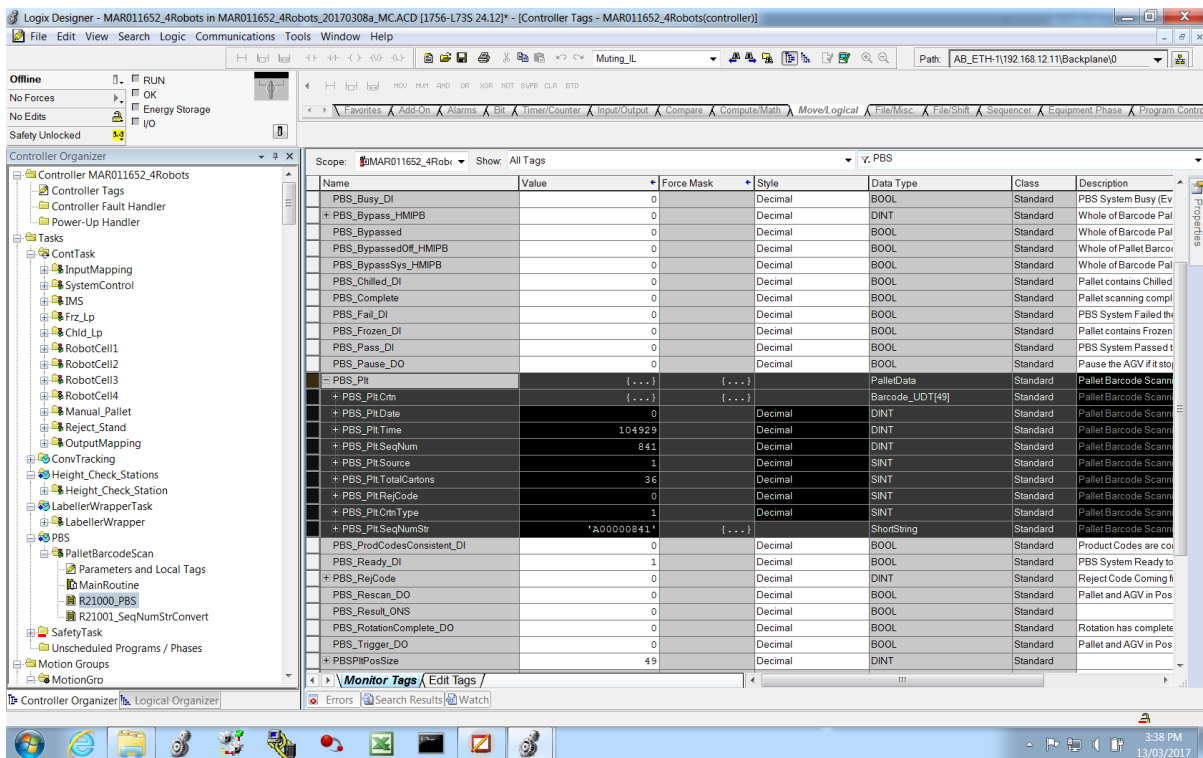


Fig. 20 Data from PLC to PBS for current Pallet at PBS complete with “Pallet Sequence No.”- PLC Code

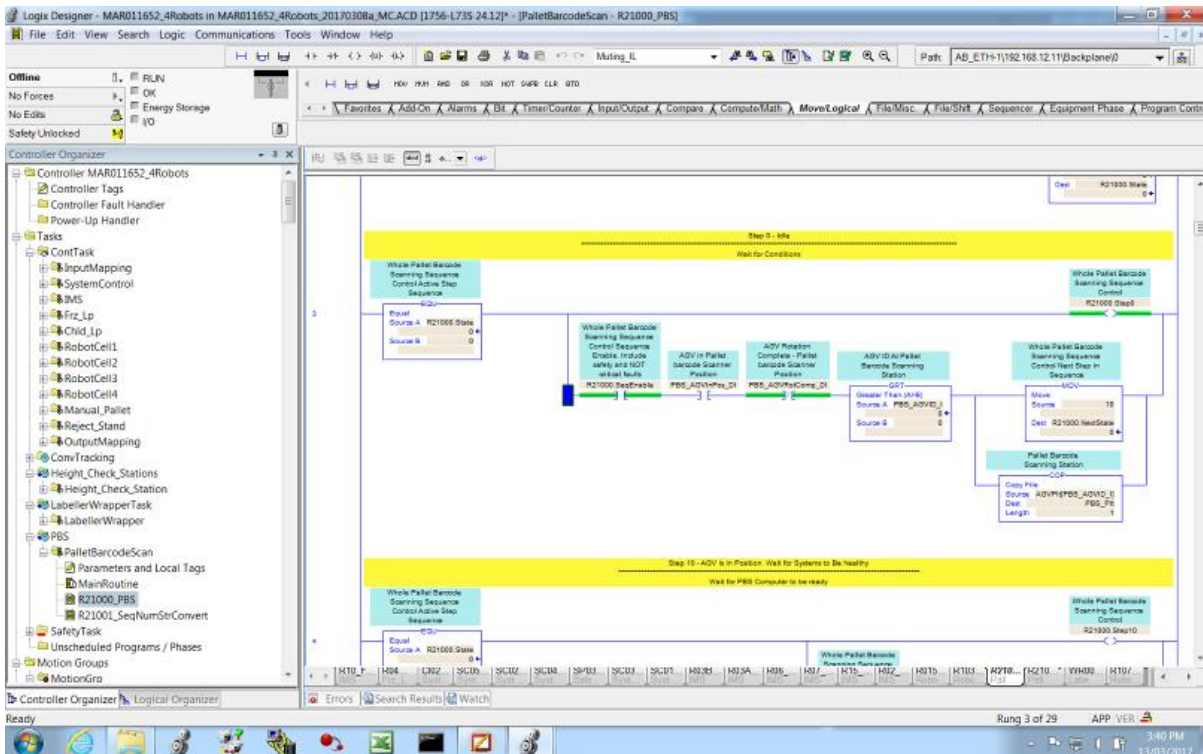


Fig. 21 PLC code waiting on next pallet to be in position to transfer data to PBS

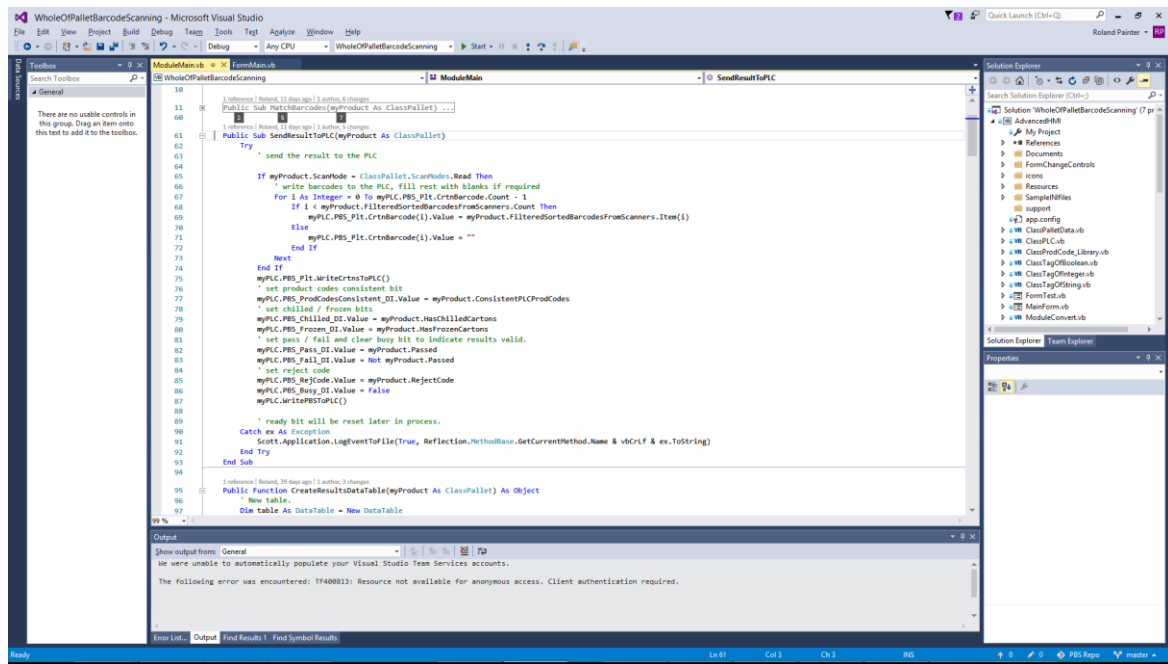


Fig. 21 PBS Code

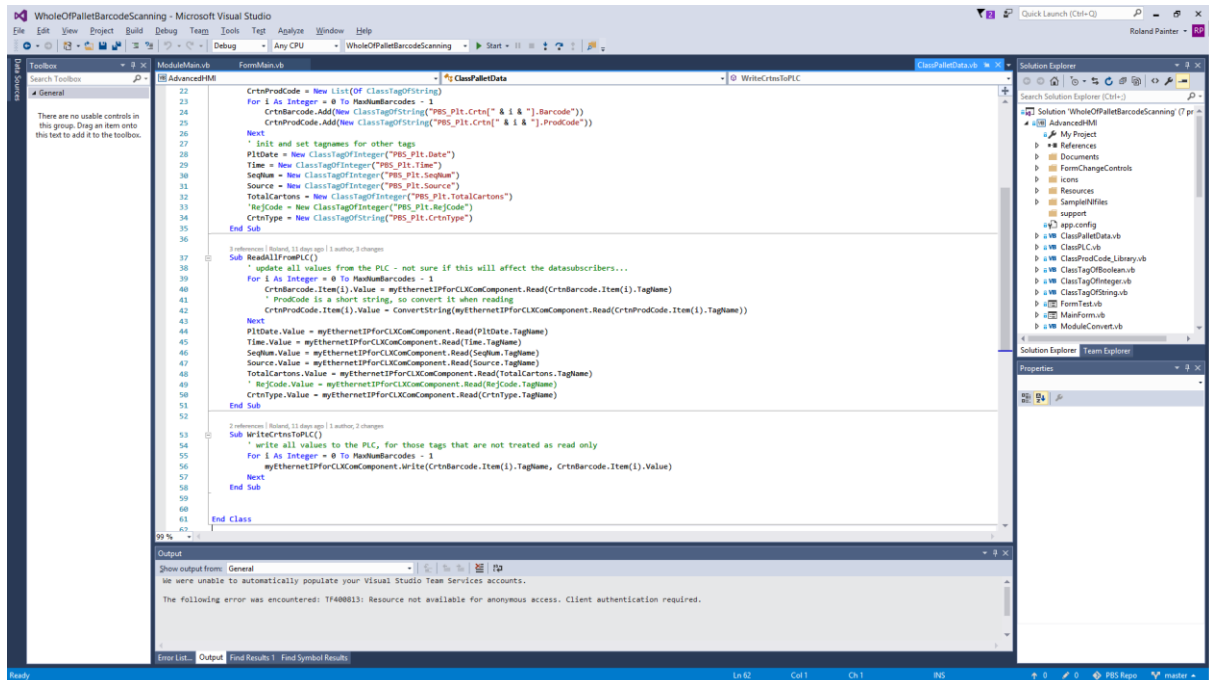


Fig. 22 PBS Code

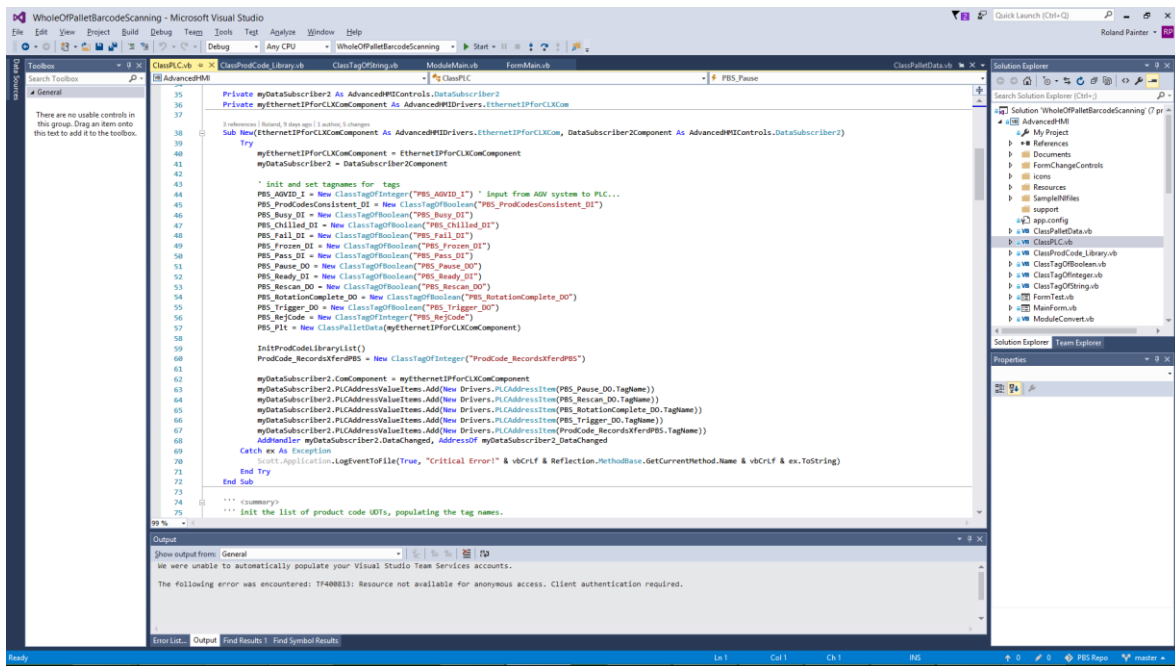


Fig. 23 PBS Code

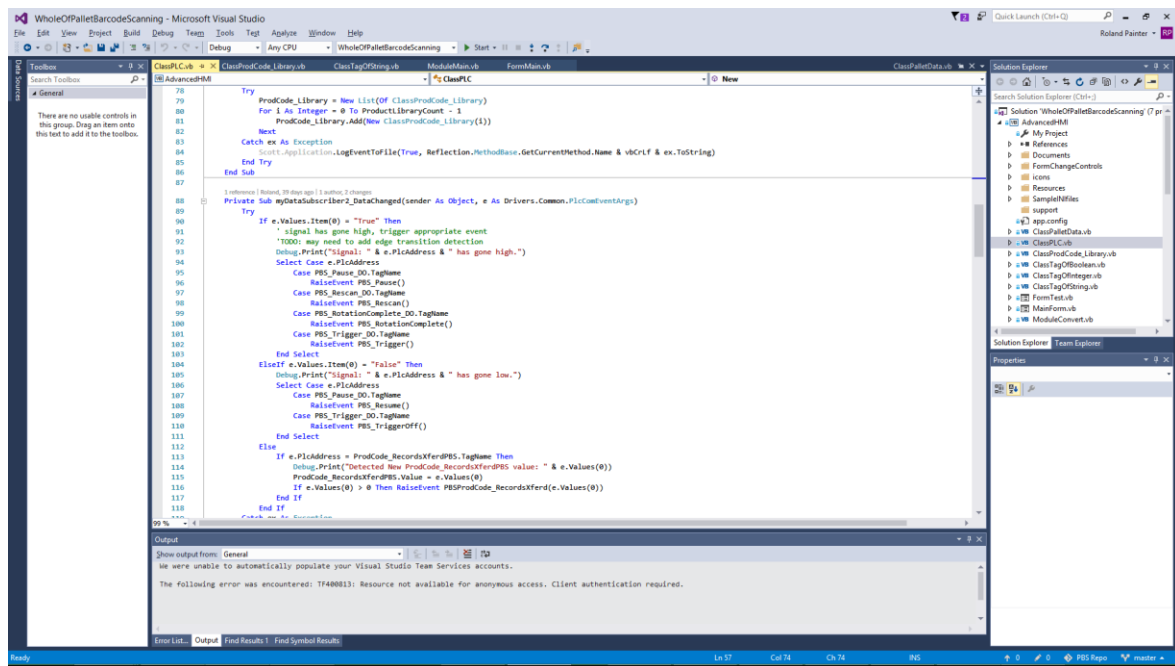


Fig. 24 PBS Code

```

128 Sub ReadPBCFromPLC()
129
130     PBS_AgVid_Value = myEthernetIPForCLXComComponent.Read(PBS_AgVid_DI.TagName)
131     PBS_ProdCodesConsistent_DI_Value = myEthernetIPForCLXComComponent.Read(PBS_ProdCodesConsistent_DI.TagName) = "True"
132     PBS_Busy_DI_Value = myEthernetIPForCLXComComponent.Read(PBS_Busy_DI.TagName) = "True"
133     PBS_Chilled_DI_Value = myEthernetIPForCLXComComponent.Read(PBS_Chilled_DI.TagName) = "True"
134     PBS_Fail_DI_Value = myEthernetIPForCLXComComponent.Read(PBS_Fail_DI.TagName) = "True"
135     PBS_Frozen_DI_Value = myEthernetIPForCLXComComponent.Read(PBS_Frozen_DI.TagName) = "True"
136     PBS_Pass_DI_Value = myEthernetIPForCLXComComponent.Read(PBS_Pass_DI.TagName) = "True"
137     PBS_Pause_DO_Value = myEthernetIPForCLXComComponent.Read(PBS_Pause_DO.TagName) = "True"
138     PBS_Ready_DI_Value = myEthernetIPForCLXComComponent.Read(PBS_Ready_DI.TagName) = "True"
139     PBS_Rescan_DO_Value = myEthernetIPForCLXComComponent.Read(PBS_Rescan_DO.TagName) = "True"
140     PBS_RotationComplete_DO_Value = myEthernetIPForCLXComComponent.Read(PBS_RotationComplete_DO.TagName) = "True"
141     PBS_Trigger_DO_Value = myEthernetIPForCLXComComponent.Read(PBS_Trigger_DO.TagName) = "True"
142     PBS_ReCode_Value = myEthernetIPForCLXComComponent.Read(PBS_ReCode.TagName)
143     'ProdCode_RecordsXfer@PBS.Value = myEthernetIPForCLXComComponent.Read(ProdCode_RecordsXfer@PBS.TagName)
144     PBS_PIC_ReadAllFromPLC()
145
146     Catch ex As Exception
147         'out.Application.LogEventToFile(True, Reflection.MethodBase.GetCurrentMethod.Name & vbCrLf & ex.ToString)
148     End Try
149
150     *** summary ***
151     *** write all values to the PLC, for those tags that are not treated as read only ie the DI's ***
152     *** csummary ***
153     'Sub WritePBCtoPLC()
154
155     Try
156         ' note barcodes are not written with this routine.
157         ' note order of writing bits leaves busy and ready till last as confirmation.
158         myEthernetIPForCLXComComponent.Write(PBS_ProdCodesConsistent_DI.TagName, If(PBS_ProdCodesConsistent_DI.Value, CByte(1), CByte(0)))
159         myEthernetIPForCLXComComponent.Write(PBS_Chilled_DI.TagName, If(PBS_Chilled_DI.Value, CByte(1), CByte(0)))
160         myEthernetIPForCLXComComponent.Write(PBS_Fail_DI.TagName, If(PBS_Fail_DI.Value, CByte(1), CByte(0)))
161         myEthernetIPForCLXComComponent.Write(PBS_Frozen_DI.TagName, If(PBS_Frozen_DI.Value, CByte(1), CByte(0)))
162         myEthernetIPForCLXComComponent.Write(PBS_Pass_DI.TagName, If(PBS_Pass_DI.Value, CByte(1), CByte(0)))
163         myEthernetIPForCLXComComponent.Write(PBS_Pause_DO.TagName, PBS_Pause_DO.Value)
164         myEthernetIPForCLXComComponent.Write(PBS_Ready_DI.TagName, If(PBS_Ready_DI.Value, CByte(1), CByte(0)))
165         myEthernetIPForCLXComComponent.Write(PBS_ReCode.TagName, PBS_ReCode.Value)
166     Catch ex As Exception
167         'out.Application.LogEventToFile(True, Reflection.MethodBase.GetCurrentMethod.Name & vbCrLf & ex.ToString)
168     End Try
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Fig. 25 PBS Code

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366 For Each nd As NetworkDevice In gSettings.NetworkMonitor.DeviceCollection
367     If nd.PrePingResult = False AndAlso nd.Name = "PLC" Then
368         StoppedAlarmIashed = True
369         ElseIf nd.Name.StartsWith("Camera ") Then
370             If nd.PrePingResult = False Then
371                 CameraPingFailedCount += 1
372             ElseIf Online Then
373                 ' get corresponding scanner array item
374                 Dim myScanner As ClassIscanCamera = ScannerArray.Item(nd.IpAddress.Split(".").LastOrDefault.Substring(1) - 1)
375                 ' check if (re)connection required
376                 If Not myScanner.myClient.TcpClient.Connected Then
377                     ' reattempt connection
378                     myScanner.Connect(nd)
379                 End If
380             End If
381         End If
382     Next
383     If CameraPingFailedCount > 1 Then
384         StoppedAlarmIashed = True
385     ElseIf CameraPingFailedCount = 1 Then
386         WarningAlarmIashed = True
387     End If
388
389     ' inhibit operation if stopped error
390     If myPLC IsNot Nothing Then
391         myPLC.ReadFromPLC()
392         myPLC.PBS_Ready_DI.Value = EthernetIPForCLXCom.Read(myPLC.PBS_Ready_DI.TagName) = "True"
393         If StoppedAlarmIashed Then "on myPLC.ProdCode_RecordsXfer@PBS.Value > 0 then ' removed check on ProdCode_RecordsXfer@PBS after implementing save / load product
394             If myPLC.PBS_Ready_DI.Value Then
395                 deactivate ready
396                 myPLC.PBS_Ready_DI.Value = False
397                 update to plc
398                 EthernetIPForCLXCom.Write(myPLC.PBS_Ready_DI.TagName, If(myPLC.PBS_Ready_DI.Value, CByte(1), CByte(0)))
399             End If
400         ElseIf myPLC.PBS_Busy_DI.Value = False AndAlso myPLC.PBS_Ready_DI.Value = False AndAlso myPLC.ProdCode_RecordsXfer@PBS.Value > 0 Then
401             ' ok to set the ready bit
402             myPLC.PBS_Ready_DI.Value = True
403             update to plc
404             EthernetIPForCLXCom.Write(myPLC.PBS_Ready_DI.TagName, If(myPLC.PBS_Ready_DI.Value, CByte(1), CByte(0)))
405         End If
406     End If
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Fig. 26 PBS Code

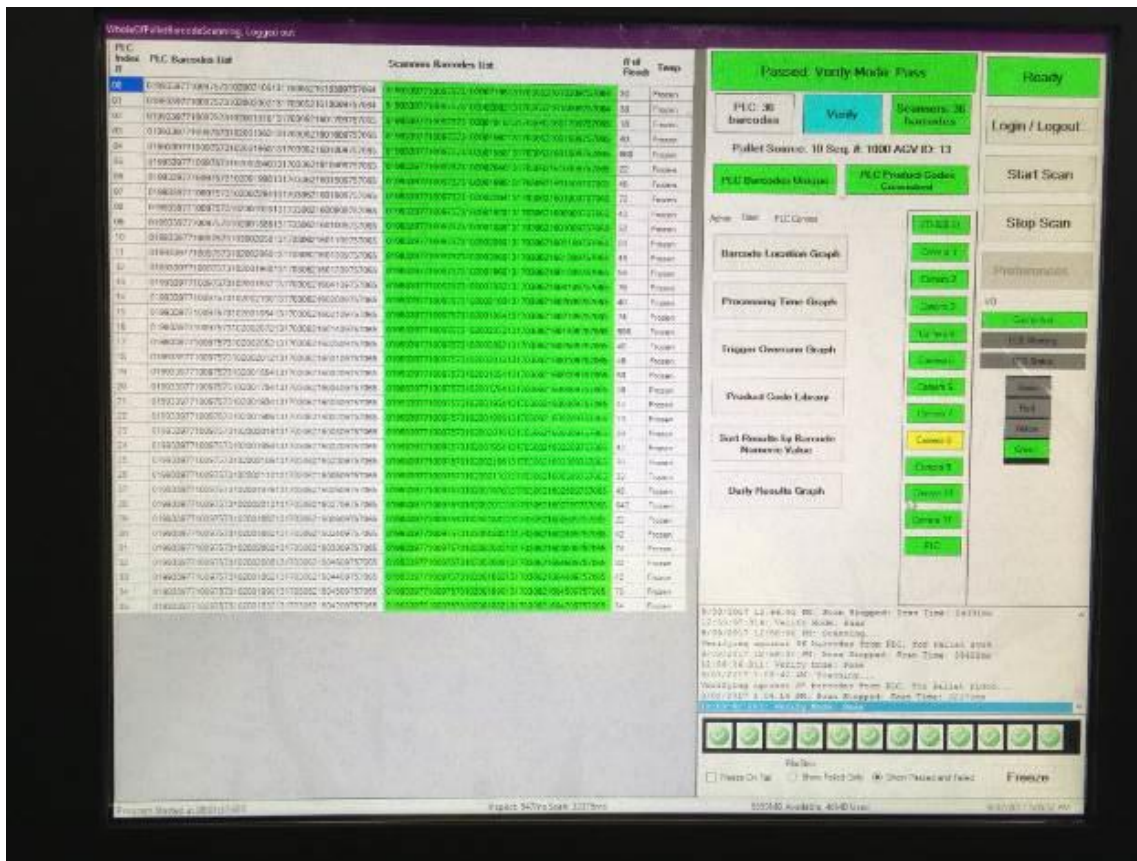


Fig. 27 HMI Screen confirming (in this case) all barcodes match.

3 Conclusions/recommendations

3.1 Success in achieving milestone

The system, as described in the previous milestone reports is now fully commissioned. All of the product handling and pallet transfers into and out of the system are being made automatically.

The robotic palletising system now functions with a minimum of operator intervention. The only interventions necessary are to remove cartons with damage from the system. Generally, cartons that deviate from the specification are ejected from the system automatically, but occasionally a carton is introduced that is vastly out of specification and must be removed manually. In this instance, the system detects the location of the carton and alerts the operator. The conveyor belts are stopped when this situation is detected to prevent damage.

Although the system is currently sorting and delivering all of the product that is being sent to it the maximum benefits are not being realised as KPC are not running the system in the way it was originally designed. When the system was originally designed it was supposed to process both chilled and frozen product at the same time. Currently due to the upstream sorting KPC have decided to run the line with chilled product on the day shift and frozen product on their night shift.

Training is complete for all necessary KPC staff. This includes:

- Operators

- Maintenance personnel.
- High-level overviews for management.

KPC staff now operate and maintain the system. Support is currently provided to KPC as required and is now being scaled back as KPC are now becoming confident with the system.

The KPC system has been used to show the industry what is achievable with today's technology. Many people throughout the meat industry have viewed the system namely:

- Representatives from JBS.
- Representatives from NH Foods.

The online publication Beef central has also featured the system in a report on 14th September 2017 and on 15th June 2018. A Video of the system has also been posted on YouTube with the permission of KPC. This video has had over 25000 views to date. The system has also been the focus of an email marketing campaign sent to our industry contacts as part of our industry awareness campaign during August 2017.