Contact Plates Inspection System

CUSTOMER INTRODUCTION:

The company is the leading manufacturer and refiner of precious metal products since many decades. It is also involved in wide and diversified industrial applications related to precious metals management. For special services and applications, this manufacturer produces specialty contact plates made up of precious metals like

Platinum, Silver or other alloys. The typical size of these plates is 3.2 mm X 3.2 mm X 0.6 mm. Other than this size there are many more variations in the size of the plates.

PRESENT SYSTEM:

Production of the precious metals is not just the aim, but to ensure that the quality of the product is preserved along with good rate of production is desirable. Currently to inspect the quality of the products, manual sorting and detection of the probable defects is done.

The produced precious metal plates are inspected by keeping those products in a Bakelite plate. Each and every product is checked manually by human eyes for any defects that may occur during the production process. Once the inspection for checking one side of the product is completed, that Bakelite plate is placed over other Bakelite plate and those plates are flipped in such a way that other side of the product can be inspected on the second Bakelite plate. This checking is done completely based on **every individual's own judgment**.

There is no control over the decision taken by the individual as per his own judgment, consequently leading to bad products being concluded as good products and good products being concluded as bad products. In either case, the result of poor judgment is unacceptable. The problem is not just limited to improper judgment but also extends to bad consistency, various factors like monotonous job, poor lighting system, noise; leading to fatigue of the person handling the products, other factors which may lead to improper judgment include one's emotional state as well as poor vision, so overall, more manpower being used for relatively less production; that too, with uncertainty about the quality of the products.

Considering the drawbacks that occurred in the present system, regarding human discretion about the product's quality, more time consumption for less production, customer wanted a solution which would facilitate, thorough, accurate, fast, sophisticated and efficient inspection of the products resulting in increased quality, production and detection of defective products on the production line, hence they approached **BAUMER**.

USER REQUIRED SPECIFICATIONS:

The requirement of the customer was inspection of minimum one hundred thousand (100,000) pieces of precious metal in a shift of seven work hours. The defects that customer wanted to detect were on both sides of the product i.e. Plain side (Top side) and Serration side (Bottom side). The defects which occur on the plain side of the product include, variation in the measurement of the product, dents, scratches, cutter marks and product being cut (as shown in table no.2). On the other hand the defect which occurs on the Serration side of the product is cross serration that means the lines of the product are not parallel (as shown in table no.3). For the reference, the good product is shown in table no.1 further;
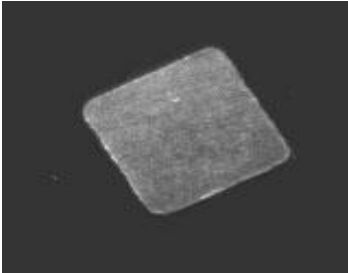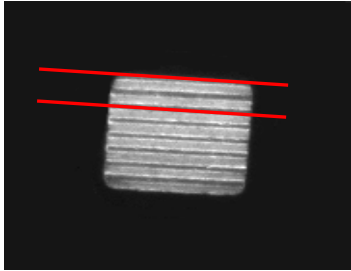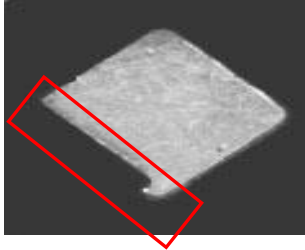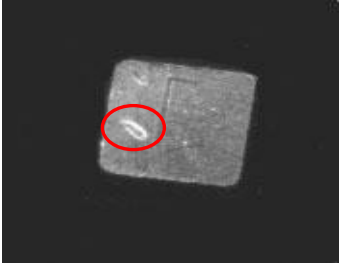
PRODUCT	VISUAL REPRESENTATION
GOOD PRODUCT (TOP)	
GOOD SERRATION (BOTTOM)	

Table No.1 - Good Product - Plain and Serration side

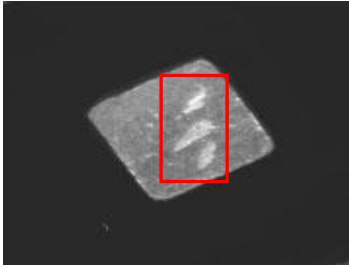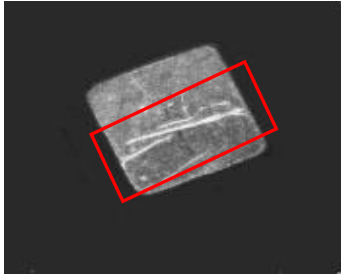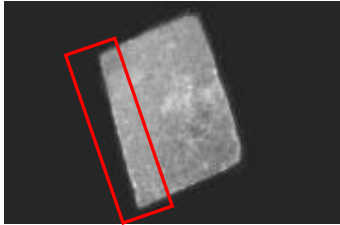All the defects has been explained below

PLAIN SIDE DEFECTS	
MEASUREMENT	
DENT	
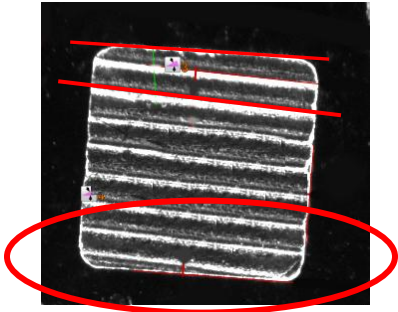
SCRATCH – 1	
CUTTER MARK	
CUT	

Table no.2 – Plain Side Defects

SERRATION SIDE DEFECT	
CROSS SERRATION – 1	

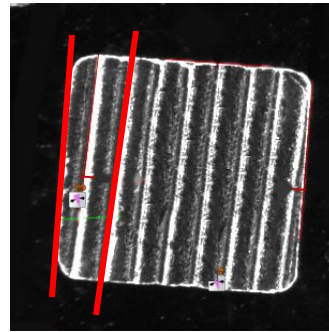|	
CROSS SERRATION – 2	

<p align="center">**Table no.3 – Serration side defect**</p>

EPSILON Solution:

After understanding the requirement of the customer, we developed an efficient solution which not only fulfilled the requirement but also surpassed the expectations of the customer. To achieve the set goal, the proposed system's operation was divided in three stages; filling stage, inspection stage and sorting stage. Each of the stage has its own working station. Unique plate, made of stainless steel has been developed which have 576 cavities. Each cavity will contain single piece of precious metal at a time for inspection. The cavities are designed, with the reference of size of metal piece to be inspected. The diameter of the cavity is 5 mm and the thickness 0.5 mm. This particular thickness is calculated so that each cavity can accommodate a single piece only. Thus, excessive pieces can easily be swiped off that cavity.

All cavities are created with nitrogen cutting in order to achieve excellent quality. Also alpha-numeric matrix is deep laser etched to enable identification & location of the defective product(s) precisely and quickly. The pieces will be filled at the filling station by the operator. After the filling work is done the plate is moved to inspection station by sliding the plate over the channel. After transferring the plate to inspection station; the operator can again start filling a new plate while in parallel the previous plate is inspected. The filling process is also very easy. The operator has to place the pieces on the plate and transfer the pieces in to cavity using nothing but hand or brush.

Filling Station | Inspection Station | Sorting Station
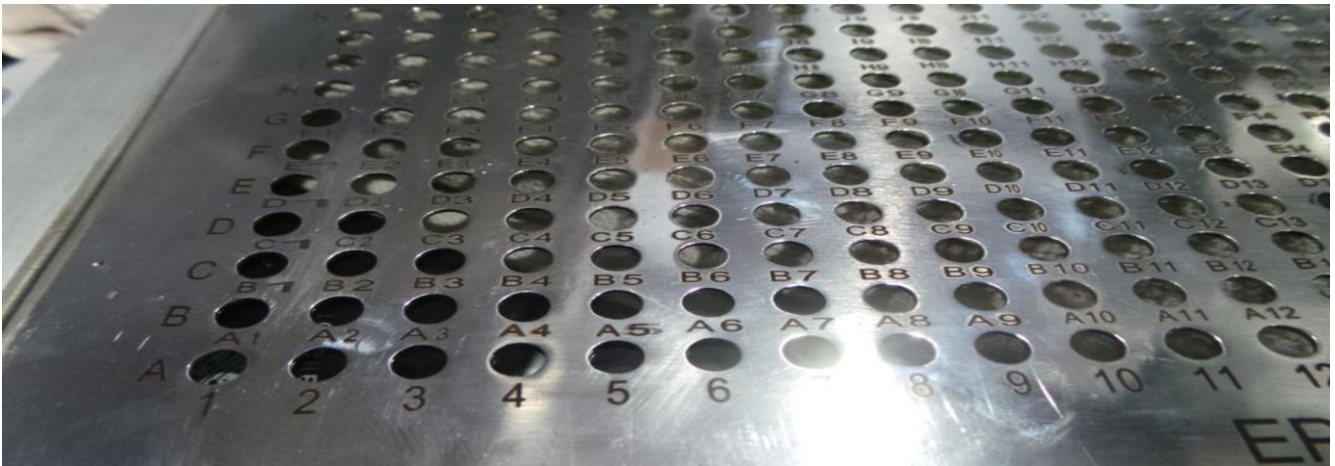
The metallic pieces are required to be inspected from both sides, so along with uniquely designed stainless steel plate, scratch proof toughened glass plate of 4 mm thickness is

attached as well. To hold these two plates together, an aluminum frame is used so that metallic pieces can be inspected on both the sides. For proper positioning of the plate at home position, notches are provided on the channel as shown in the figure above, so that the plate would hold its position. The wheels of the aluminum frame will rest in the notches, thus metal pieces will be in steady position during inspection process.


NOTCH

WHEEL
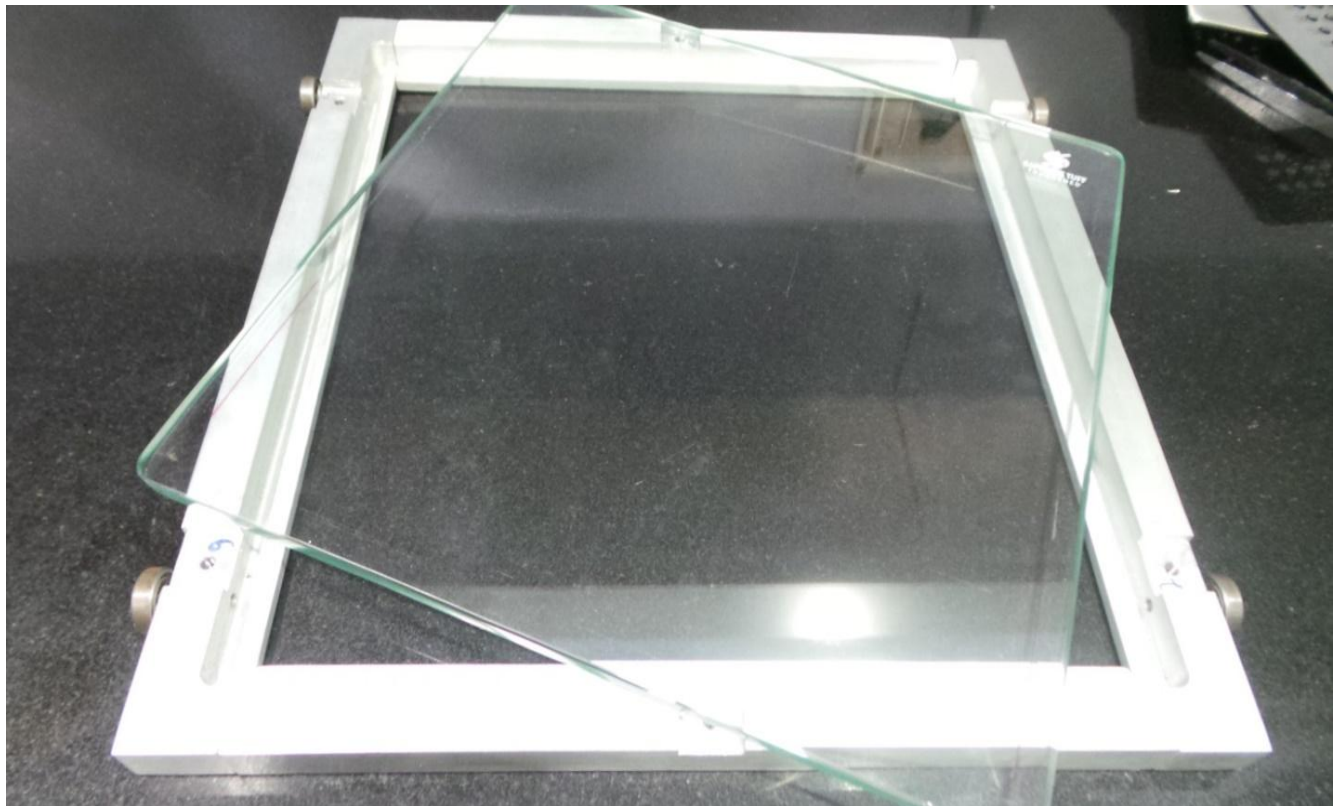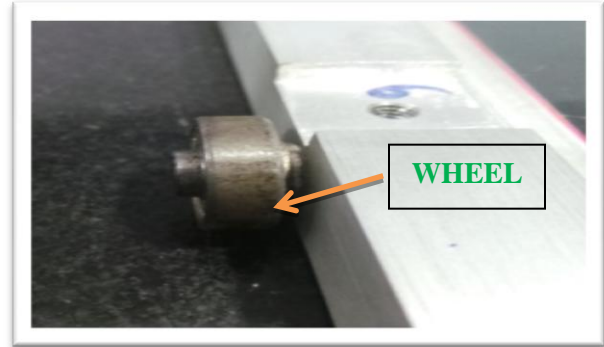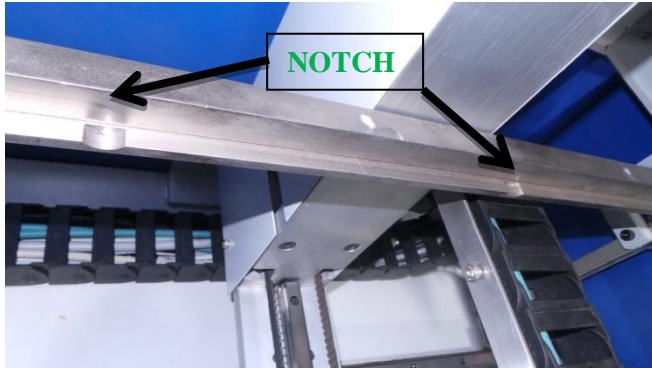
Now at the inspection station, 2 MP high resolution BAUMER (VERISENS XC 700) smart cameras are used for the detection of defects. Ultrahigh optical quality 'Tamron' lens (8mm) with superior locking mechanism are used for reducing the distortion of the images during the operation to the absolute minimum. Due to such mechanism stabilized performance has been achieved. During the ongoing operation it is unknown

to camera which side of the metal pieces is facing upwards and similarly which side is facing downwards.
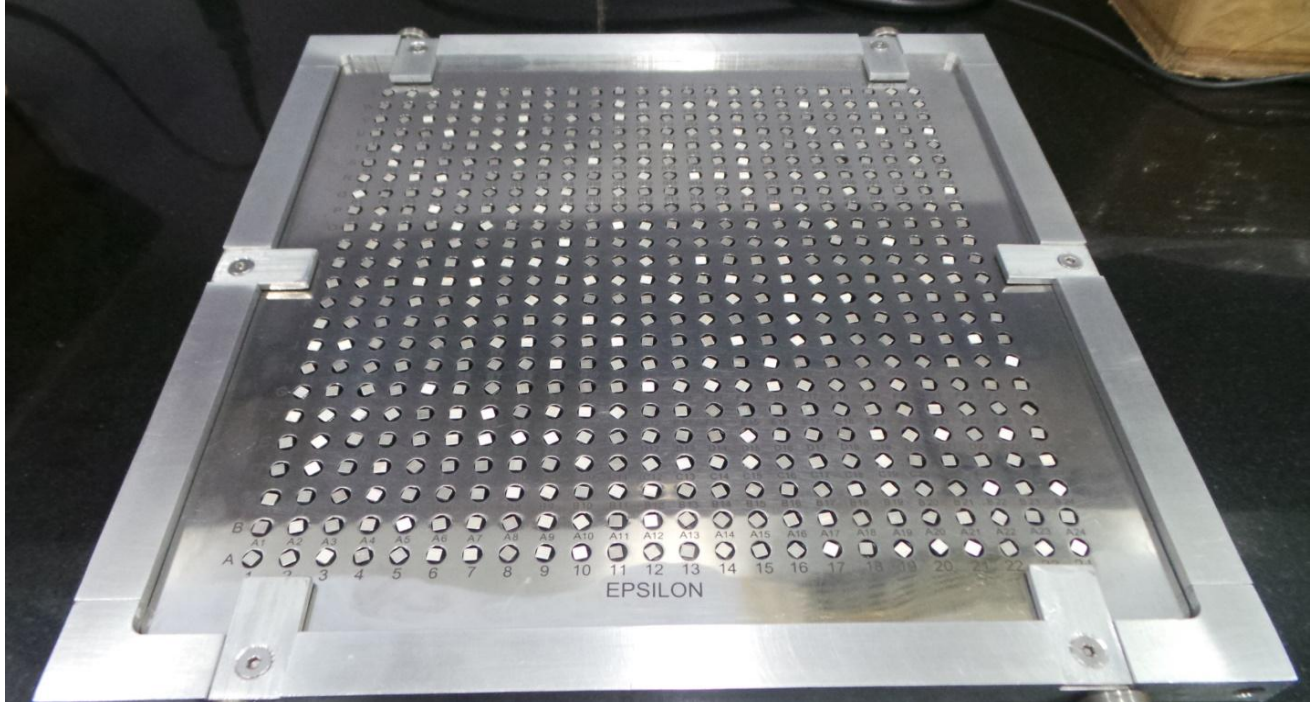
Therefore one inspection consists of two cycles. So to ensure that cameras check both sides for the presence of plain as well as serration, logic has been designed. While performing the first cycle, top camera checks defects of plain surface and bottom camera checks for serration surface. Later, while performing the second cycle, the programs are interchanged, i.e. top camera checks defects of serration surface and bottom camera checks of plain surface.
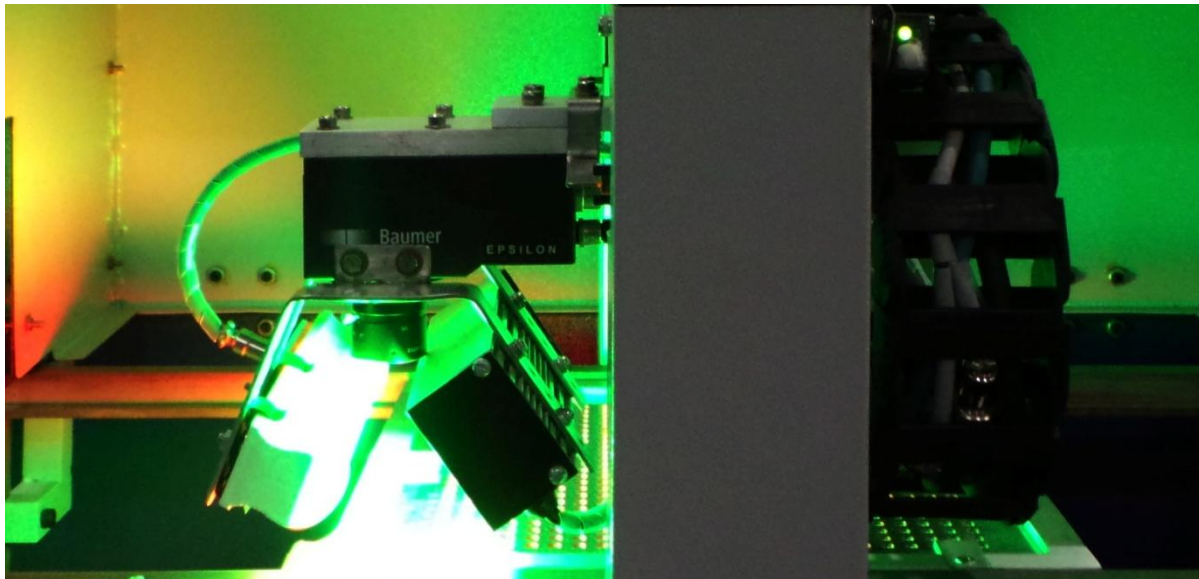
After the initial experimentation, it was observed that scratches, dents were difficult to detect on shiny metal pieces. So to counter this problem, we specially designed our own application – specific highly diffused 150 mm light most suited for the application as shown below.

Total 4 Lights are used, 2 lights for each camera. 1 light will turn ON while inspecting plain side while both lights will turn ON for serration side. It enables scratches and defects to be uniformly illuminated and also able to view serrations with high contrast. LED light driver is specially designed for driving the Diffused bar light. It has been used to avoid the fluctuations in DC power supply, and maintain this supply to a constant value.

All the metal pieces are inspected in a particular predefined manner. Camera has been programmed in such a way that it checks three metal pieces at a time. To check all the other metal pieces, camera is moved step by step, using two servo motors with high-precision positioning. All the metal pieces are distributed in a matrix of 24 X 24, so camera has to move along X- and Y- axis. Of those two servo motors one motor moves the camera along X-axis while other motor moves the camera along Y-axis. Hence, to complete one inspection of five hundred seventy six metal pieces, camera requires 47 seconds. To control motion of these two servo motors, Schneider Electric's servo motor drivers, Lexium '23' are used in this system.

For the reference of home position and to avoid the mechanical damage that could be done by servo motor in the extreme conditions, four photoelectric slot sensors are used, which dictate the servo motor system when to change the direction of the motors. Two switch mode power supplies (SMPS) are used, one for variable frequency drive (VFD); PLC and other for camera and lights.

Both the cameras send real time data to software for the processing purpose. Data processing is done in software. High quality Industrial Ethernet switch is used in this system to facilitate the communication between PLC, cameras and software. This switch is reliable and secure for data communication. Also, Ethernet cabling used in this system is CAT6 with clip guarded RJ45 connectors.

Once the inspection is completed at the inspection station, the operator can move the plate to sorting station over the same extended channel. Post to which the operator can easily remove the defective pieces by observing the results on the monitor screen.

Software overview

Software GUI is designed keeping in mind the convenience of the operator for understanding and usage of the system. The software is designed using .NET and Visual Basics, also graphical user interface is provided. For optimal performance of this system, the software is installed in DELL personal computer, having powerful specifications like, 64- bit Intel I7 processor, 8 GB RAM, Windows 10 operating system. Software is the linked between PLC and cameras, and has three level hierarchies for Operator, Supervisor, and Manager.

This software facilitates customer with various options, through which inspections can be executed. From the Master menu, customer can manage all the settings of plates, products and user. By using "Manage Plates" option, customer can add new plates just by putting number of rows and columns. By using "Manage Product" option, customer can change the different Servo motions, travel limits, and speed that can be controlled by entering values through software. No need to make changes in PLC. By using "Manage User" option, customer can manage different users and define the access rights to each user. In the Batch Execution menu, customer can select the type of product to be inspected during that batch and start the machine by clicking play button followed by physical start button. The real time data will be displayed on the screen as shown below;
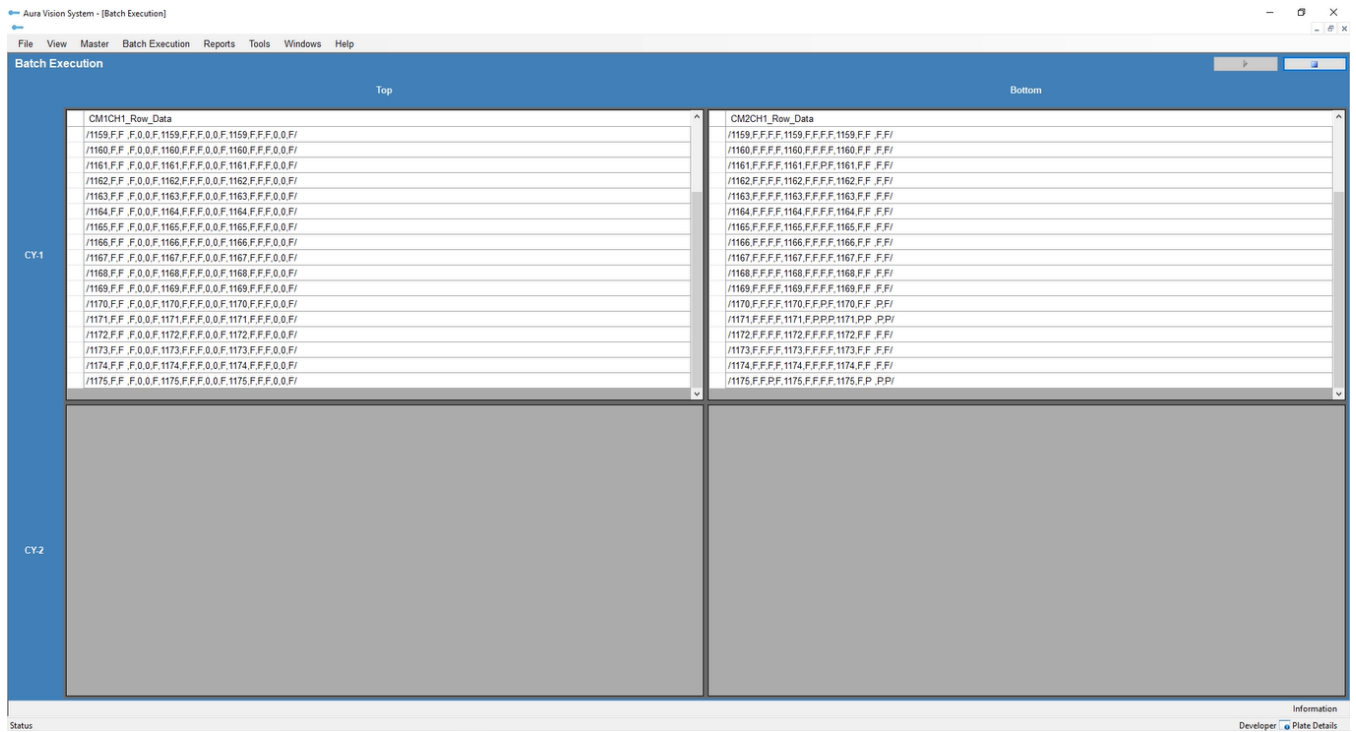
Furthermore, in the Tools menu, there are various options like, 'Application Options', which allows user to change the server name, database and IP of top as well as bottom camera also camera port number. Also, to set PLC registers for different functions; 'Manual Action', which allows user to simply set camera to home position, turn ON/OFF the continuous trigger of camera, set speed of X &Y axis, turn ON/OFF auto cycle.

This software also creates the report generation of the completed inspections, which contain detailed analysis about batch, plates, failed products, passed products, date and time of the batches etc. This software also enables user to select the types of defects required in the report and generate the report in the PDF format, it also stores the report in the specified location path.

TOP Left   Trial Test by EPSILON   TOP right

Start Date	Start Time	End Date	End Time	Plate Name	Start Time	End Time	Product Name	Pass	Fail	Reason	Reason Details
09/06/18	2:03 pm	09/06/18	2:04 pm	Plate 24 X 24	2:03 pm	2:04 pm	Product 3.2 X3.2		6	CS	CS
09/06/18	2:03 pm	09/06/18	2:04 pm	Plate 24 X 24	2:03 pm	2:04 pm	Product 3.2 X3.2		7	FAIL	FAIL
09/06/18	2:03 pm	09/06/18	2:04 pm	Plate 24 X 24	2:03 pm	2:04 pm	Product 3.2 X3.2		2	M	M 1: 0.000 M 2: 0.000
09/06/18	2:03 pm	09/06/18	2:04 pm	Plate 24 X 24	2:03 pm	2:04 pm	Product 3.2 X3.2		1	M	M 1: 3.154 M 2: 0.000
09/06/18	2:03 pm	09/06/18	2:04 pm	Plate 24 X 24	2:03 pm	2:04 pm	Product 3.2 X3.2		2	M/SD	M 1: 0.000 M 2: 0.000 / SD
09/06/18	2:03 pm	09/06/18	2:04 pm	Plate 24 X 24	2:03 pm	2:04 pm	Product 3.2 X3.2		1	M/SD	M 1: 2.743 M 2: 3.246 / SD
09/06/18	2:03 pm	09/06/18	2:04 pm	Plate 24 X 24	2:03 pm	2:04 pm	Product 3.2 X3.2		1	M/SD	M 1: 2.834 M 2: 3.246 / SD
09/06/18	2:03 pm	09/06/18	2:04 pm	Plate 24 X 24	2:03 pm	2:04 pm	Product 3.2 X3.2		1	M/SD/CS	M 1: 0.000 M 2: 0.000 / SD/CS
09/06/18	2:03 pm	09/06/18	2:04 pm	Plate 24 X 24	2:03 pm	2:04 pm	Product 3.2 X3.2	453		PASS	PASS
09/06/18	2:03 pm	09/06/18	2:04 pm	Plate 24 X 24	2:03 pm	2:04 pm	Product 3.2 X3.2		102	SD	SD
				Plate 24 X 24	2:03 pm	2:04 pm		453	123		
09/06/18	2:03 pm	09/06/18	2:04 pm					453	123		
Grand Total:								453	123		

THE END USER CHRISTENED THIS SYSTEM AS *"AURA VISION SYSTEM"*

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