

Using infrared cameras for process control

Ron Predmesky, Ford Motor Company
Terry Ruane, FLIR Systems, Inc.

ABSTRACT

This paper will detail how infrared cameras can increase the quality of parts produced for automobile manufacturing. It will define the levels of automation available for addressing the many process applications required building automobiles. Examples will be used to match levels of automation with solutions. Basic visual monitoring of infrared images on a television monitor (insuring all heating elements of a rear window defogger are operational) to the full automation of a CAB furnace. In each instance the cost savings will be discussed for justifying this approach.

Keywords: Infrared thermography, process automation, automotive manufacturing, cost savings

1. INTRODUCTION

Several applications of thermal imagers (infrared cameras) to process automation in the automotive industry will be presented with commentaries from the points of view of the user (FORD) and the thermal imaging equipment manufacturer (FLIR)

2. CASE 1- REAR WINDOW DEFOGGER

Ford Motor Company:

We are in need of a method to inspect rear window defoggers, in the three glass plants that are operated by Ford Motor Company. This needs to be an in-line process that can be either automated or done visually by a line worker.

What we are looking for in this inspection is a way to assure that the on glass printed circuit, which is silver/platinum ink, is continuous and has no defects. The slightest defect in the printed circuit can cause the rear defogger to work improperly or fail. **Figure 1** is a thermal image of showing defogger defects in a rear window.

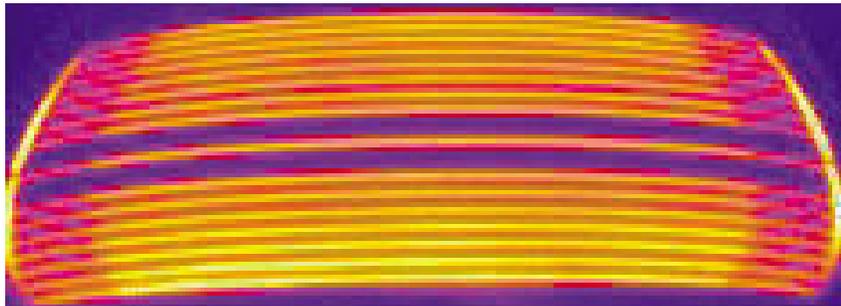


Figure 1. Thermal image of rear window showing defogger defects

FLIR:

Ford has a failure rate of 1 in every 50 rear window defoggers. The defects can be anything from a nick to a miss-print of the on glass circuit. Based on a conservative estimate the process monitoring system should price out at ~\$25K. Currently the defoggers are tested by the operator. He swipes his hand across the rear window and senses heat. This technique limits the detection of the defogger being on or off.

Ford wanted to improve the testing to include any grid faults that could create problems after the vehicle is delivered to the customers. Our recommendation was to use a Thermovision 320V camera and TV monitor. This allows the operator to visually see the defogger grid and easily detect grid line discontinuities, uneven heating, etc.

This system improved the fault detection and eliminated costly warranty repairs in the Field.

3. CASE 2- FOAM DASHBOARDS

Ford Motor Company:

The quality of foam backing in dashboards is a very important issue in the operation of airbag deployment (see **figure 2**). Every dashboard needs to be inspected. The teardown method (total destruction) was the costly method of choice. Teardown involves the removal of the vinyl covering and the cutting of the foam. Defects can affect the way the airbag deploys. A defect can cause the airbag to deflect to one side or the other instead of directly in front of the passenger. A non-destructive method of testing would avoid tearing down 1 in every 5 dashboards made.



Figure 2. Typical dashboard airbag release panel

FLIR:

By utilizing and IR Thermovision 320 and Lab view software we were able to monitor the heat pattern around the airbag release panel. The heat pattern around this panel is critical. There are two areas of concern. First, if the hot melted glue spreads into the fiberboard reinforcement slot that releases the airbag a failure could occur. There is also the possibility that the airbag could shatter the fiberboard releasing dangerous fragments injuring the occupants. Second, any voids in the foam backing can affect the deployment of the airbag and need to be addressed.

The liability involved helps justify a 100% check of each dashboard. The Thermovision 320M monitors the process while Labview software checks for higher temperatures that appear when glue flows into the release area. If a failure occurs the operator is warned by a flashing light and the process is halted.

4. CASE 3- CAB FURNACE

1. Ford Motor Company:

A majority of aluminum heat exchangers are currently brazed in a Controlled Atmospheric Braze (CAB) furnace using flux and an inert gas atmosphere. These furnaces are usually 200 feet long and operate in a batch mode, which is very slow when switching between different size heat exchangers and radiators. In designing a new CAB furnace (see **figure 3**) Ford Motor Company wanted to reduce the floor space requirements, reduce operator intervention to produce quality parts and implement just-in time manufacturing practices. Fuzzy logic control is critical to the next generation CAB furnace design. At the center of any control logic would be a thermal model capable of not only predicting current part temperatures on a "real time" basis, but would also allow the product design engineer to develop and input a set of boundary conditions for a particular part geometry.



Figure 3. Controlled Atmospheric Braze (CAB) furnace

FLIR:

We were called in early for meetings with Ford Motor Company, Rogers Corp (furnace manufacturer), Georgia Tech (fuzzy logic) and the University of Michigan (software). We were asked if it was possible to provide real time temperature data of the parts being sent through the furnace. We suggested that two infrared imagers be used in the front and back quarter of the furnace. The imagers needed to be able to send data that the fuzzy logic system would be able to recognize and feed information back to the furnace controller. The furnace controller would control both the furnace temperature and the belt speed. Thus the importance of camera selection. The 320M infrared camera was selected for this application.

5. SUMMARY

The use of infrared imagers in process control is a key component in maintaining quality of an automated process. Today the automobile industry is under the microscope of public organizations that list the number of defects each automobile experiences after the cars are sold. Organizations like J.D. Powers list car models according to the number of defect(s) found. Infrared cameras are one of the new technologies that will help the auto industry reduce the number of these defects.