Design of Experiments for Non-Destructive Testing of 3D AM Components.

CLARK ATLANTA UNIVERSITY

Dual-Degree Engineering Program

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DESIGN PROBLEM

Problem Statement

•During the fabrication process, metallic AM parts/alloys experience complex thermal history involving directional heat extraction, repeated melting and rapid solidification/cooling. Although services for testing such components are growing, the process of Non- Destructive Testing (NDT) could get very lengthy and expensive. Thus, it has started to create a demand for qualified individuals (Work Force Development) in the area of NDT. Qualification and certification has been repeatedly identified as a challenge to widespread adoption of AM components. Hence, technological alternatives for an accelerated qualification of NDT are needed. Hence the benefits and need of this CAM-MSIPP Project

Design Objective

•To design Experiments so that we can produce very clear indication of the location, size, shape and position of defects in both small and large 3D Metal components.

Design Requirements/Constraints

•The jury is still out on the several non-destructive inspection methods that exist today, which are being applied to evaluate the integrity of industrial equipment and which raise several questions such as: What are the most reliable methods? Which of them provide lower decision risks? Is there an ideal method for a given type of component/equipment? Does a more reliable inspection method also cost more?

Design Criteria

The solution of the above stated problems using the X-ray was most accurate, due to being able to see the flaws in the component.

Figure 1. Using X-ray c-scan showed the flaws in the titanium component through several layers.

DESIGN SOLUTION

•Nondestructive testing modalities rely on different physical phenomena such as electromagnetism, acoustic emissions, thermal emission and high-energy radiation penetration through materials. This diversity in Nondestructive testing tools is only matched by its fields of application such as testing of mechanical structures and components, online monitoring of manufacturing processes and products. Following from the above, the specific Nondestructive testing techniques explored here at CAU include- ultrasonic testing methods, X-Ray, and neutron radiography. X-Ray method is showing a lot of promise compared to other NDT techniques.

Figure 2. The USIP-12 Ultrasonic Flaw Detector supplied by KCP used in the first testing trials. These trials were inaccurate.

RESULTS

Testing Results

Figure 3. Images taken from a CT-Scan using the X-Ray technique.

Validation Results

The needs of NNSA, MSIPP, and CAM Outfit have been met.

Final X-Ray Scan

DISCUSSION/CONCLUSION

- These results suggest that the most accurate results in the area of NDT lies within the X-Ray method.
- This development is important, because using X-Rays as a form of non destructive flaw testing enables a tester to visually pinpoint defects on a monitor, and the results can be shown in color too
- Future advancements in this area of testing should focus on minimizing the time it takes to scan an object, before X-Raying defects.
- We are now in the process of designing experiments to accommodate the Three (3) new Components recently delivered to CAU by KCP and we are very hopeful.

Instructor: Dr. Cyril Okhio

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