BITES - An Expert System For Integrated Circuit Board Inspection

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Abstract - This paper describes an expert system known as BITES (an acronym for integrated Board Inspection and Training Expert System). BITES is designed for two purposes: 1) automation of inspection process performed by knowledgeable inspectors or quality control technicians; and 2) for use as a training tool for new inspectors.

INTRODUCTION

An Integrated Circuit Board (ICB) is a complicated system with many components. An ICB could be a printed circuit board (PCB), VLSI, or electronic circuit board (ECB). To produce and market a quality and reliable ICB, a good inspection strategy is necessary during the manufacturing phase of production. Usually, the ICB inspection is done by humans, combining judgement and systems functionality to make a decision.

The BITES architecture and paradigm are built to bridge the gap between the two modeling philosophies in the area of diagnostic reasoning. From the artificial intelligence (AI) point of view these modeling philosophies are understanding causality [1,2,3], and traditional fault models [4-5].

During an ICB inspection, human errors can occur in different modes. Some of these modes may be detection of the defect characteristics in an object through visual perception, identification of product state (good or bad), decision making (e.g; accept or reject) in attribute sampling, and taking action. The latter problem, is result-motivated behavior based on some cognitive attributes [6]. For example, recording a symbol on a chart to indicate the result of experimental observation and/or measurement. Sometimes, a technician may erroneously classify a diagnosis of a particular system. Such an error may be a direct result of an action oriented behavior in the present of several stimuli. The ICB inspection process fits the description above - diagnosis, monitoring, information processing, and decision-making.

In the ICB inspection domain, there exists a variety of knowledge and data on how humans inspect. The methods may vary from one inspector to another. However, the goal is to detect defects and make a decision on whether to scrap or accept the product.

With the existence of "expert" inspectors and a large volume of data on ICB quality inspection tasks, our aim is to develop an expert system that can integrate these various sources of knowledge into a single decision support system. The expert system is developed using the GURU™ [7] expert system shell.

2. THE BITES ARCHITECTURE

BITES is a concept demonstration of an expert system advisor for inspection in an ICB domain. BITES is an architecture based on an explicit representation of inspection strategy and the use of available knowledge to facilitate inspection process as well as a tutoring system for new inspectors. Instead of diagnosing the ICB, it
incorporates the MYCIN medical decision strategy [5] with the inductive cause-effect reasoning strategies. The strategic knowledge of the inspectors is abstractly embedded in the BITES inference engine (see Fig. 1).

The strategic knowledge shows how the inspector identifies defects in the ICB. Thus, in BITES the production rules target the explicit behavior of the inspection decision process rather than trouble shooting and diagnosing ICB functions and behavior [5].

As shown in Fig. 1 BITES is consulted by the user while in the GURU environment. After consultation, BITES internally loads its knowledge base which consists of: a) defect classification knowledge base, b) human inspector’s line of reasoning in defect location during inspection, and c) a GURU spread-sheet data that contains defect modes, identification numbers, likely causes of defects, possible remedies, likelihood of defect occurrence, and defect source location (i.e., the production process or center where the defect is suspected to have taken place). Exhibits 1-2 show the ICB environment for knowledge acquisition and experimentation with the BITES architecture. Currently, BITES has 140 rules on five possible defective modes. That is about 28 rules identified per defective ICB occurrence.

3. CONCLUSIONS

BITES, an expert system for ICB inspection decision support and new inspector’s training has been presented. BITES is a rule-based expert system whose knowledge is shallow and domain-dependent on the ICB inspection strategy and available records. BITES inference engine is driven bilaterally by reasoning strategies that are both judgmental and strategic. We have outlined the BITES architecture and those things it can be used for. As it is, BITES is described and modeled as a demonstration system.

REFERENCES

Exhibit 1

Top view of circuit board

Bottom view of circuit board

Top view of circuit board

Bottom view of circuit board