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Information model for the integration of inspection activity in a concurrent engineering framework

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Abstract

The basis of the integration of activities related to the product life cycle is, mainly, the creation of a unique and coherent information model along all the stages in the cycle. Up to date, dimensional inspection activities have not been deeply analysed, possibly due to the fact that, their work influences are smaller than others, such us numerical analysis, materials or numerical control. However, the integration of dimensional inspection is very important for several reasons: the need of specifying the design and planning of the inspection process from the conceptual part design; the increase of use of high speed coordinate measuring machine (CMM) in the production lines; and finally, for the interest of a feedback between data inspection and manufacturing processes. This paper is a detailed proposal of an information model for inspection based on operations for CMM, which represents a consistent structure of the necessary data in an integrated product setting.

Keywords: Coordinate measuring machine; Computer Integrated Manufacturing (CIM); Information modelling; Concurrent engineering; Standard for the exchange and sharing of product

1. Introduction

The integration of activities related to the product life cycle is being studied and developed by several research groups all around the world. The basis of this integration is, mainly, the creation of a unique and coherent information model along all the stages in the cycle. The importance of this integration and its world wide acceptance was definitively assumed in the middle of the 1980's when the STandard for the Exchange and sharing of Product (STEP) model data initiative was launched under the approval of ISO [1].

Due to the complexity and wide scope of the problem to solve, different research groups are focusing on specific stages of the production cycle but keeping the provided partial solution under the common framework of STEP. So far, most of the work is related to design, product data management, and Computer Numerical Control (CNC) planning and programming. Until now, dimensional inspection activities have not been deeply considered in this integration effort, possibly because their influence in the whole process is considered to be less relevant than the design or machining activities. Refs. [2–4] are examples of different work related to product integration using STEP. A more detailed reference list of research work can be found in the references [5,6].

However, the integration of dimensional inspection is very important for several reasons: the need of specifying the design and planning of the inspection process from the conceptual part design; the increase of use of coordinate measuring machines (CMMs) in laboratories; the increase of use of high speed CMMs in production lines, above all in sheet forming; and finally, provides a feedback between data inspection and manufacturing processes. In the 'integrating community' it is widely recognised that the concurrent use of design using features, the application of knowledge based systems and the modelling of information leads to a better integration of production activities [4].

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The work presented in this paper is a detailed proposal for an information model for inspection based on operations (inspection operation features) for CMMs. The information contained in the data objects defined will allow the implementation of a knowledge based system.

The decision of defining inspection operations is a continuation of the work proposed by Ríos [6] for CNC programming based on machining operations. The proposed solution provides an inspection activity systematisation and a consistent structure of necessary data to integrate the inspection process in a concurrent engineering environment.

2. Functional model for the inspection with CMMs

This model represents the flow of activities to be carried out during the process of inspection using a CMM. For its development, the activities that take place along the process have been identified and analysed, focusing specially on the type and flow of information among them. This functional analysis makes it possible to systematise the subsequent development of the required data structures, which are included in the information reference model presented further in this paper.

The IDEF0 [7] modelling technique has been used for the functional model definition. Fig. 1 shows the first level of activities, where four main ones have been considered: identification of elements to inspect, determination of inspection resources, detailing of inspection plan, and execution of inspection and analysis of results. This leaf provides a general perspective of the scope considered in the developed work. The complete decomposition of these main activities and their description can be found in the work by Barreiro [5].

The input and output data flow analysis in each activity and their sub-activities enables identification of a set of information requirements. These requirements have been divided into 13 groups according to their functionality, which are described in the next section. These groups have been organised in two models: the product model and the process model, as Fig. 2 shows.

The interaction between these two models must be direct for the implantation of a concurrent engineering framework. Consequently, the information structures included in each of them must follow the same criteria in structure and meaning. This organisation of the information groups makes easier the access and sharing of the data related to the product and to the process, allowing a correct application of the ‘design for inspection’ concept and the feedback of inspection results backwards the previous production stages in the product life cycle.

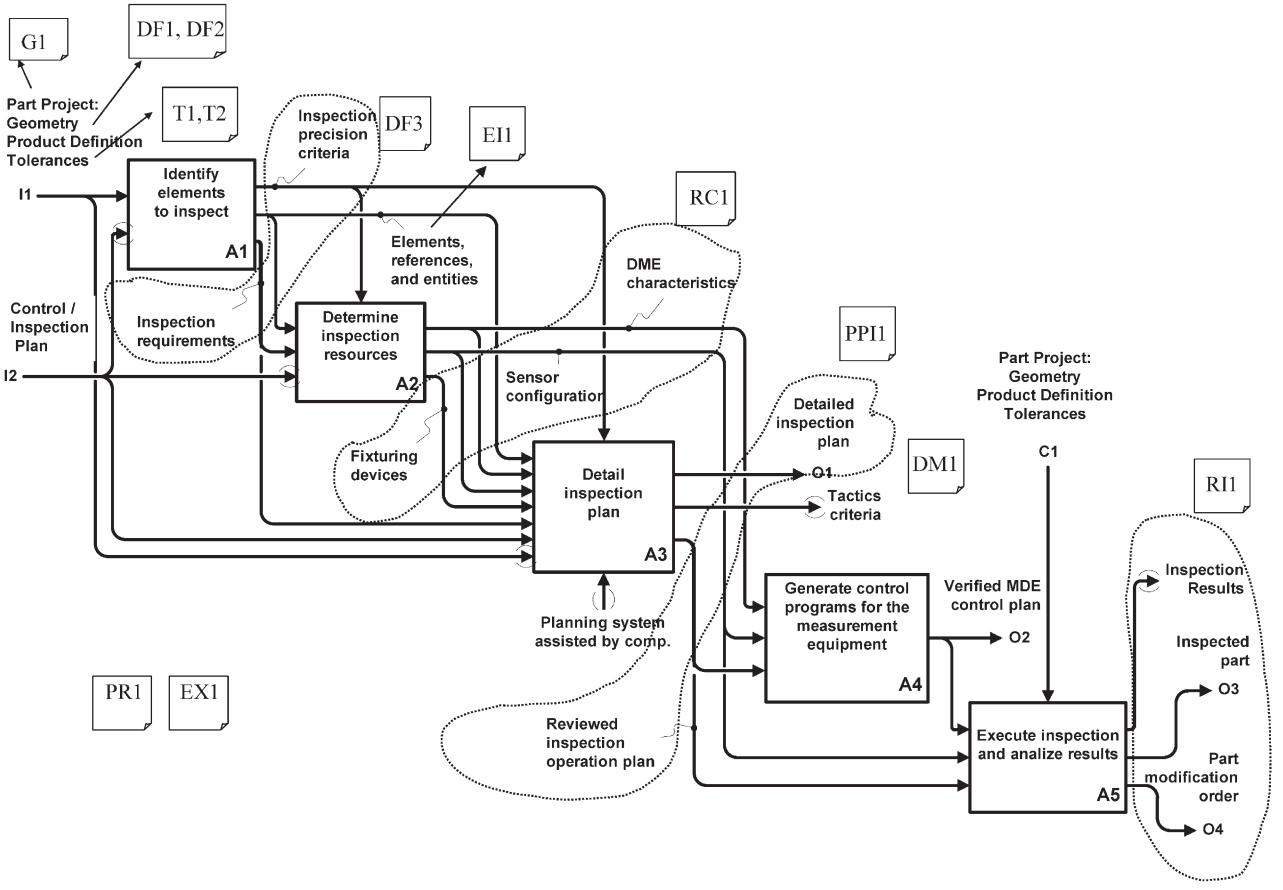

Fig. 1. Information groups.