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INSPECTION FEATURE FOR INSPECTION PROCESS PLANNING

BRUSCAS BELLIDO, G[racia] M; GUTIERREZ RUBERT, S[antiago] C[arlos]; ROMERO SUBIRON, F[ernando] & ROSADO CASTELLANO, P[edro]

Abstract: *In this paper an entity, the Inspection Feature, is proposed to interpret a part in the inspection domain. This entity contains relevant information, in addition to part geometry and GD&T, to carry out Supervisory Inspection Process Planning.*
The Inspection Feature has been defined and typified considering the essential relationship between product functionality and its verification procedure.
Key words: *inspection feature, inspection process planning,*

1. INTRODUCTION

Traditionally, Inspection Process Planning has been mainly focused on the development of operational measurement plans using CMM. Moreover, Inspection Process Planning has often been treated as an independent function, lacking an effective coordination with other activities of Product-Process-Resource Development.

These facts lead to less flexible and dynamic inspection plans than the ones required by nowadays manufacturing systems. To avoid this, Supervisory Inspection Process Planning should be carried out at the same level and integrated with Manufacturing Process Planning and Engineering Development.

Main functions of Supervisory Inspection Process Planning include: inspection process determination; assignment of resources (instrument, equipment, machine, probe, etc.) capable of inspecting part geometry; and sequencing and grouping inspection operations, with the required effectiveness and efficiency according to part specifications, inspection process uncertainty, and technological and productive restrictions.

In order to realize knowledge intensive Supervisory Inspection Process Planning with high reasoning capabilities and as part of a Collaborative and Integrated Product-Process-Resource Development System, approaches based on sharing merely geometrical product information are not sufficient (Rosado & Romero, 2009). An engineering approach based on *Application Features* where geometrical information can be enhanced with more information and knowledge specific to the application domain is necessary.

Several works can be found in the literature with proposals of entities to be used to carry out Inspection Planning. However, most of these works use as entities for Inspection Planning dimensional, geometrical specifications (tolerance) and basic part geometry (surface, point, line) (Pfeifer et al., 2002). Additionally, many of the proposals are restricted to just one type of inspection resource, i.e. CMM or on-machine probe (Barreiro et al., 2003).

Next, an Inspection Feature for Supervisory Inspection Process Planning is proposed and described to overcome previous shortcomings and incorporating the GPS approach (ISO/TS17450-1, 2005), where part design and verification of manufactured part ought to follow parallel procedures.

2. INSPECTION FEATURE

2.1 Definition

The *Inspection Feature* (InspF) to be proposed should contain part geometry and all those attributes and knowledge useful for the reasoning process necessary to obtain an Inspection Process Plan at the required supervisory level in order to verify part geometrical specifications. To verify means, to obtain enough information about final part geometry to check whether specifications determined by functional requirements are met. Product functional requirements refer to the mating of the part with other parts of the final product, either during product assembly or product service (product mating). For this purpose, the designer intention must be extracted by the inspection planner to guarantee consistency and a more effective verification process.

Hence, and based on previous work (Gutiérrez et al., 2009), an InspF is defined as: ñA geometry or group of geometries of a part participating in one o more functional chains (product mating). This geometry can interact with one or more specific measurement procedures with the purpose of extracting geometrical information of real or constructed elements, either intrinsic to the feature or concerning the feature orientation or/and position in relation to other part features.ò

The InspF will contain:

(1) Information that instances the own feature and its relation with other features:
- Part geometry or group of geometries participating in product functional chains.
- Intrinsic (internal, external, offset or other) and extrinsic (datum or measurement element) dimensional and geometrical specifications, that provide information about how feature participates in functional chains.
- Minimum relative movements (d.o.f.) between part and inspection equipment required during measurement.
- GPS geometrical constructions required for verification.

(2) Other relevant information for Supervisory Inspection Process Planning:
- Reference system.
- Manufacturing set-up when InspF is created.
- Possible probe access directions for measurement.
- Functional importance and inspection scope (100%, sample, in-process, post-process, etc.).

2.2 Inspection Feature library

According to the previous definition an InspF library is proposed. The library offers an adequate quantity and typology of InspF for part interpretation.

- *InspF Cylindrical or conical surface* represents a product mating where just feature own geometry participates in the functional chain. Feature geometry is generated by a rotation of a straight line about an axis.
- *InspF Revolved surface* represents a product mating where just feature own geometry participates in the functional

chain. Feature geometry is generated by a rotation of a non straight line about an axis.

- *InspF Plane surface* represents a product mating where just feature own geometry participates in the functional chain. Feature geometry is generated by a straight sweep of a straight line.
- *InspF Straight sweep surface* represents a product mating where just feature own geometry participates in the functional chain. Feature geometry is generated by a straight sweep of a non straight line.
- *InspF Non straight sweep surface* represents a product mating where just feature own geometry participates in the functional chain. Feature geometry is generated by a non straight sweep of a line.
- *InspF Median axis* represents a product mating where feature geometry participating in the functional chain is a derived median axis of two revolved surfaces.
- *InspF Median plane of planes* represents a product mating where feature geometry participating in the functional chain is a derived median plane of two planes.
- *InspF Median plane of non plane surfaces* represents a product mating where feature geometry participating in the functional chain is a derived median plane of two non plane surfaces.
- *InspF Median surface of straight sweep surfaces* represents a product mating where feature geometry participating in the functional chain is a derived median surface of two straight sweep surfaces.
- *InspF Median surface of non straight sweep surfaces* represents a product mating where the feature geometry participating in the functional chain is a derived median surface of two non straight sweep surfaces.
- *InspF Free form surface* represents a product mating where the feature geometry participating in the functional chain is a free form surface.
- *InspF No mating feature* corresponds to part geometry that does not participate in any product mating. The objective is just to establish size and form proportions for the part.
- *InspF User defined* is defined by the user to represent a specific product mating not being considered by the previous features.
- *InspF Pattern* is the result of grouping two or more identical features following a particular repetition pattern in the part and representing, as a group, a product mating.

3. EXAMPLE

Figures 1, 2 and 3 illustrate an example, where a part is interpreted from an inspection point of view using the proposed InspF concept and library.

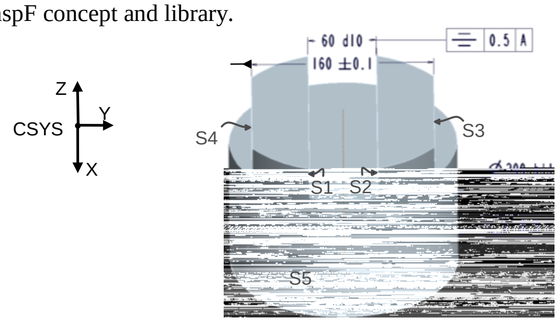

Fig. 1. Example of part with some geometrical specifications

1.- InspF Cylindrical surface
• S5. • 200h11, intrinsic, external. Roundness, measured element.
• 1 rotation + 1 radial translation (i.e. Vee block + dial indicator).
• Determination of associated derived centre. Distance calculation.
• CSYS. • Turning machine. • XY plane. • Important, 50%.

Fig. 2. Part interpretation based on proposed InspF

2.- InspF Median plane of planes
• S1, S2. • 60d10, intrinsic, internal. Symmetry, measured element.
• 2 translations on plane + 1 perpendicular translation (i.e. Flatness table + gauge with dial indicator).
• Association of 2 plane surfaces extracted from S1 and S2. Determination of associated derived median plane. Distance calculation.
• CSYS. • Milling machine. • (1,0,0), (-1,0,0). • Critical, 100%

3.- InspF Median plane of planes
• S3, S4. • 160±0.1, intrinsic, internal. Symmetry, datum.
• 2 translations on plane + 1 perpendicular translation (i.e. Flatness table + gauge with dial indicator).
• Association of 2 plane surfaces extracted from S3 and S4. Determination of associated derived median plane. Distance calculation.
• CSYS. • Milling machine. • (1,0,0), (-1,0,0). • Critical, 100%

Fig. 3. Part interpretation based on proposed InspF

4. CONCLUSIONS

Taking into consideration the essential parallelism between design intent and verification procedures, an *Inspection Feature* has been proposed. A taxonomy based on useful metrology criteria (i.e. measurement data extraction and its treatment) has also been developed, not being limited to just one kind of inspection resource.

The proposal allows horizontal (Aggregate, Supervisory and Operational Process Planning) and vertical (Product-Process-Resource Development) integration.

Future work will extend the application of the proposed Inspection Feature to also consider process functionality, that is, mating of the part with other elements of the working station (fixture, tool, etc.) during part manufacturing (process mating), strengthening integration with Manufacturing Process Planning.

Furthermore, since a feature-based approach has been used future integration of proposal with norm ISO10303 is feasible.

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