TRACEABILITY A NEW APPROCH TO OBTAIN DECISION-MAKING AID

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Abstract

From a general perspective, including both the medical and technical case, diagnosis can be explained as follows. For a process there are observed variables or behaviours for which there is knowledge of what is expected or normal. The task of diagnosis is to, from the observations and the knowledge, generate a diagnosis, i.e. to decide whether there is a fault or not and also to identify the fault. But to obtain a diagnosis, it is necessary to have accesses to this various information. It is not always the case. Thus, to thwart this problem, we use the concept of traceability with methods and tools which we developed. This paper presents the interest and the state of our research concerning the development of a cognitive system of decision-making aid applicable for the production's follow-up, where the operator is included in the production. We chose to illustrate our step with an industrial example of manufacture of piece for cars.

Keywords: Traceability, decision-making, fuzzy sets, possibility theory.

1 Introduction

1.1 Diagnosis

Diagnosis is the process of identifying a disease by its signs, symptoms and results of various diagnostic procedures. The objective of the diagnosis is to give to an operator or a higher level of supervision of information on the anomalies which occurred in the supervised system. A system of diagnosis can be seen like an "intelligent" sensor which treats observations in order to provide observations of higher level, targeted on the anomalies. Consequently, the treatment carrying out the diagnosis consists in extracting the "signs" and the symptoms, most relevant of the observations available.

But all that has just been known as is valid only when we have information to carry out the diagnosis. In the contrary case, either one modifies the process to obtain information on this one, or one seeks missing information, by tracing them, which will enable us to obtain an approximate diagnosis. It is this second option: “tracing” which we will detail in this article.

1.2 Traceability

Since the crisis of Bovine Spongiform Encephalopathy, the traceability term acquired its letters of media nobility. Currently the word is abundantly used in the agribusiness sector, but also in others domains like the automobile industry or New Technologies Information and Communication. Actually, we can say that the traceability is one of the essential concerns as regards quality (Arana, 2002). But for the general opinion, the traceability is synonymous with "find a culprit" (person in charge), (Vellemans, 2005), and not to seek the cause of the faulty operation. Thereafter, we will present in this paper the concept of improvement’s traceability, which is in our opinion a tool to implement a product’s and process’ follow-up. So, the first objective of the traceability is to be able to find, the trace of all the stages of its manufacture and source of all its components and vice versa (IS0 8204). It also offers the advantage of being able to intervene upstream of the distribution, while making it possible; for example, to control the product quality until the origin of its raw materials. That permits a clear reduction in the costs of non quality intervening traditionally on the finished products.

2 Context of research

2.1 Presentation of the industrial process

The study case with which we confronted is the production follow-up of an aluminium piece support, (Vellemans, 1994), Figure 1.

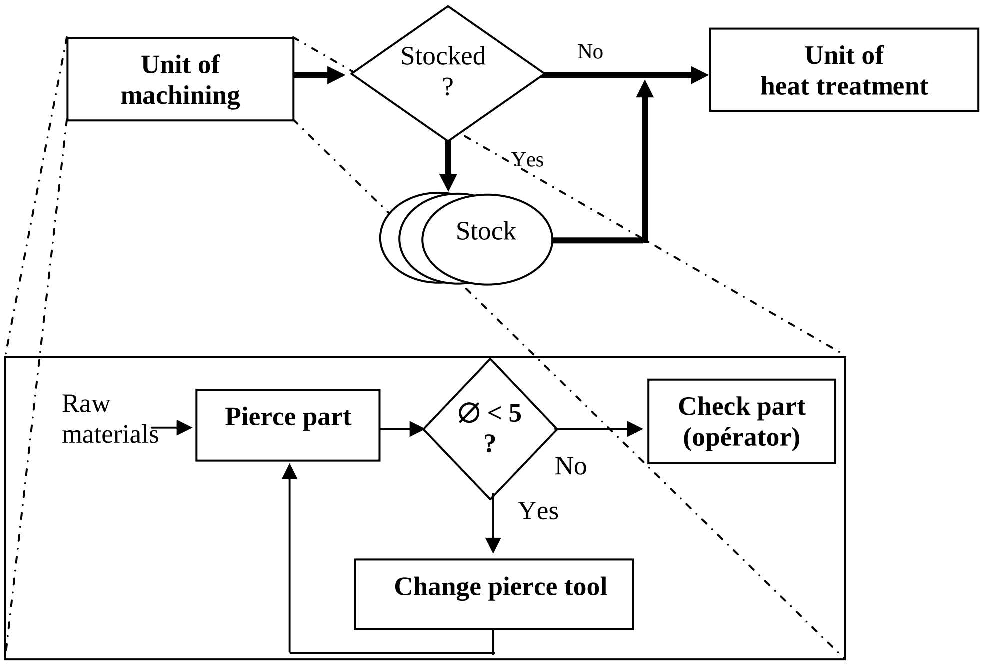

Figure 1 : Simulation of parts machined production and treated thermically.

This last is made up as follows:

- A unit of machining: drilling of a part, according to a defined diameter,
- A stock,
- A unit of heat treatment.

2.2 Throughout a production

At the beginning of production chain, our part undergoes a machining and receives, at end of machining, a number (which we use only as witness), a time (instant of machining end) and a diameter (which varies with time). Then, this one is stored (or not) by an operator. According to the storage parameters, the part is piled up either in "First In First Out" or in "Last In First Out" (we stopped with these two academic cases, which at all doesn't prevent the addition of other stacking kinds). Moreover, a time of storage can be allotted to him (this time makes it possible to represent time during which the parts remain in a stock). Lastly, an operator brings the part to heat treatment: parts are treated by batch (a part number per batch is to be defined). So, the parts come out from this treatment with three new parameters: the instant of heat treatment end (that we use only like witness), a pH and a treatment temperature. Through the operator intervention, the parts in the batches are put random away. We have just seen that the parts, constituting the batches, can be mixed in a random way, in order to be able to represent the total loss of traceability and by this fact, the inconsistency of the data within the system. Thus, the production parameters of a part correspond any more neither to the part number, nor at the instant of machining end. The most annoying consequence is that theoretically rejected parts will be considered as consumable and reciprocally. To obtain an idea of the information loss evolution, we varied the number of parts constituting a batch (see Figure 2). So, when the parts in the batches are ordered, we obtain, logically, a traceability of 100 %. On the other hand in the contrary case, we lose this traceability very quickly.

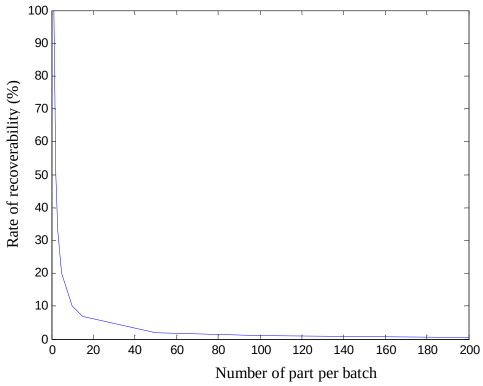

Figure 2: "Recoverability" rate according to the part number constituting a batch.

3 Contribution

3.1 Traceability with the expert's aid

To summarize the context: we machine parts (Figure 3). Once forwarded by stock, the parts are treated thermically. This treatment is carried out by batch. The batches constituted of parts, are take in stock by random (Figure 4). So, our goal is to find the order -the traceability- of the parts once those treated. To recover the traceability by the histories rebuilding, we need the expert knowledge.

This last will have as task to model, by segments, (Figure 5), the type of curve which one should obtain according to parameters' of the system. To allow rebuilding histories according to the expert model (Figure 7), we use a linear regression method: least squares method (Figure 6).

So, these histories rebuilding enable us to solve the problem of production follow-up and thus of part traceability; consequently, at every instant, we have an idea of the part position through the production and thus a thorough knowledge of our system. On the other hand, this traceability is only one model of the parts diameters evolution. Consequently, if we determine that the whole of the parts whose diameter is lower than a certain threshold (for our case, equal to 7), we cannot affirm that all the parts, whose diameter is lower than 7, are rejected parts and reciprocally.

So to affirm or cancel that a part is rejected, we used the fuzzy sets, defined in the [0, 1] interval by membership functions (Zadeh, 1965). In practical applications, the trapezoidal membership functions provide generally a good representation of the subjective information (Ölmez, 2002), (Sayed, 2005).

3.2 Precision of the defective parts localization

The membership function enables us to give the truth degree of the assertion: “this part is a reject”. The membership functions offer a great flexibility at the time of modeling. The disadvantage of fuzzy sets is that they represent primarily the imprecise information nature, uncertainty being represented in an implicit way and is accessible only by deduction from the various membership functions. A membership function is not a measurement of confidence; on the other hand, the possibilities’ theory introduces such measurements on fuzzy sets (Dubois, 1988).

The possibilities’ theory, derived from the fuzzy sets, provides two measurements of confidence making it possible to represent knowledge on a field. They are measurements of “possibility” and “necessity”. The first constitutes the most pessimistic measure (or most careful) and represents a degree preferably; whereas the necessity measurement translates the priority character of an event. (The results, on this part, are on the validation way.)

3.3 Localization of the removed parts

When machining is finished, an operator controls the parts, this one removes the parts which have defects (at this stage, the operator doesn’t have any possibility of measuring the part diameter). These parts eliminations, at machining end, are not reflected in the data base. Thus, we cannot know if a part “α” is include in the production; if it isn’t the case, we don’t know the moment to which this one was

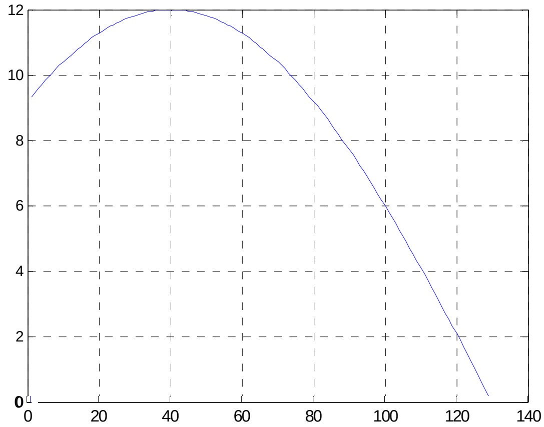

Figure 3: historic at the end of machining.

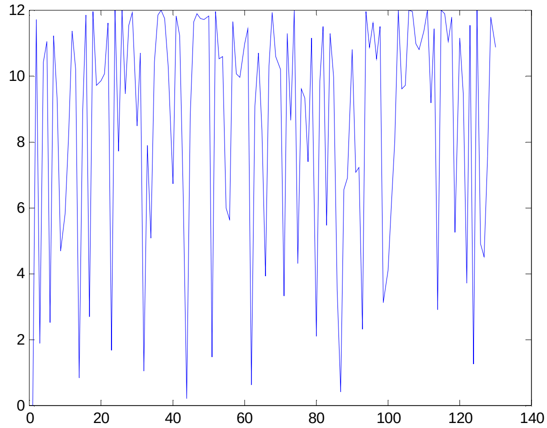

Figure 4: parts are taken in stock by random.

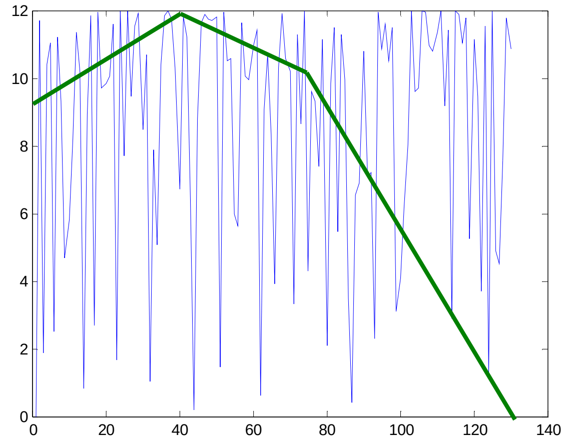

Figure 5: Model of expert, by segments.

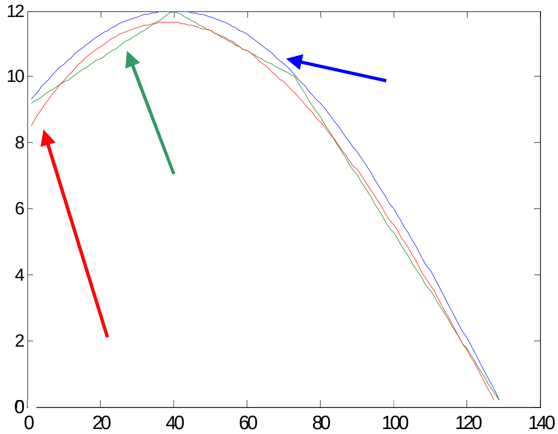

Figure 6: Extrapolation of segments.

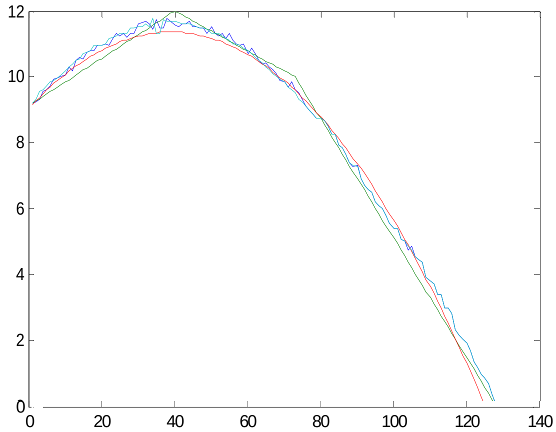

Figure 7: Rebuilding of histories.

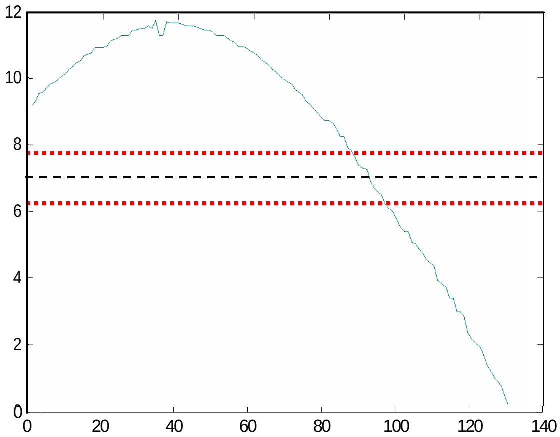

Figure 8: area of uncertainty

Blue: data of process.
Green: operator's model (segments).
Red: extrapolation of segments.
Light blue: rebuilding histories.

removed from the production. To cure this information loss and to determinate the instant when the part was removed, we use the operator observations; this one will have to indicate, Figure 9:

- The instant to which the part was removed
- An interval of time, which makes it possible to encircle in a more flexible way the instant of suppression,
- The confidence degree which it has for information above.

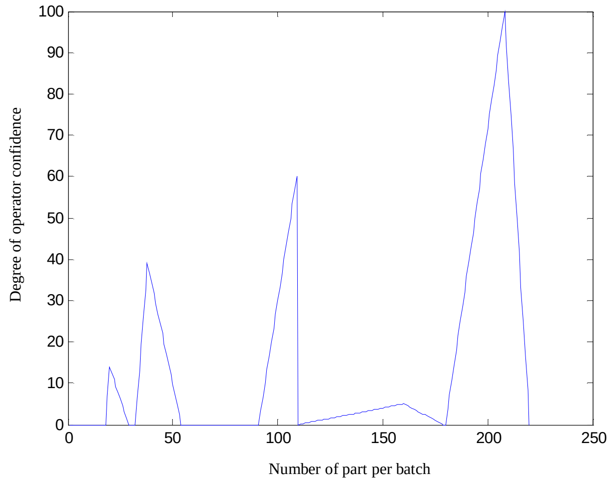

Figure 9: Data relating to the parts losses.

Thanks to this last information, we will be able to have traceability even more effective and obtain better results (reduction of badly classified parts percentage) at the time of the various histories rebuilding.

4 Progress report

We were interested in this article to the follow-up of part production. The diversity of information relating to the products gives more and more problems of management and especially of the production follow-up. To compensate for this lack of legibility through a production, we will use the concept of traceability. So, in the first time, we tried to rebuild the historic of the production for that we used the fuzzy sets and more exactly the memberships' functions associated with the possibilities' theory. These combined methods enable us to represent the imprecise and uncertainties of the data; and give us the possibility to determine the defective parts appearance, which enables us to obtain a more precise rejects' detection and consequently, thereafter, a better diagnosis. In the second time, we are confronted to the loss of data. To solve this, we use the operators' knowledge; what enables us to add knowledge with our system, in order to obtain more reliable and more robust traceability. The next stage (which is in the finalization step) is to provide to the operator a human adapted tool for a diagnosis aid, which will give him an overall vision of the system; over a time of production, for example, and/or the product evolution will show to him, at every moment "t", throughout the production chain.

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