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Intelligent personal assistant concept in context of fault analysis

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The authors of the paper took up Aoyama's [2–6] concept of the integrated industrial processes intent analysis and linked it with the ideas of the designer's IPA (Intelligent Personal Assistant) [23–26]. In many cases it is not sufficient to analyze the engineer's intent depot when trying to explain the origin of a fault. Often computer models are built or real experiments are done with which the considered classes of problems can be analyzed better. The IPA concept was expanded for the process of building computer models and stands for the fault analysis.

Keywords: personal knowledge management, fault analysis

1. INTRODUCTION

Nowadays, the information and knowledge which appear during a design process, the preparations for the manufacturing, the manufacturing itself, the use and the servicing of a product have become the center of interest [2–8, 30, 31]. Numerous attempts can be observed integrating these pieces of information with the product and the process documentation [6–8, 14, 20, 21, 23–27]. The results of these attempts vary strongly, depending on the researcher's domain or the industry which was involved. There are no standards concerning the research proceedings and often different problem representations are applied. But for many issues knowledge concerning the realities of the particular industrial process is a condition.

One of the most interesting concepts of the last years was developed by Aoyama [2–6]. He tried to build a software which comprises the individual knowledge depot for three groups of engineers: those who design, those who prepare manufacturing processes and those who are responsible for the quality control of the final product (Fig. 1). Aoyama's work was inspired by faults occurring in automotive industry. Before we take a closer look at these faults we must understand the knowledge intentions and the design rationale of the engineers from the different groups and find out what models were used in each. Looking into product documentations, the cooperation among the respective engineers is not very close in general. When the designer has finished his work he usually presents it to his succeeding, co-operating engineers in the form of geometric models and technical drawings. But this standardized product documentation does not allow conclusions concerning the author's rich inferencing, his decision making processes and their description which accompanies the designer's work [27, 29]. What the production engineer finally obtains from the designer is rather a kind of protocol, sometimes enriched by information through personal contact. In most cases, however, it reflects only a limited perspective of the whole problem. On the basis of this knowledge the manufacturing process is established and also documented. In the last stage the final manufacturing

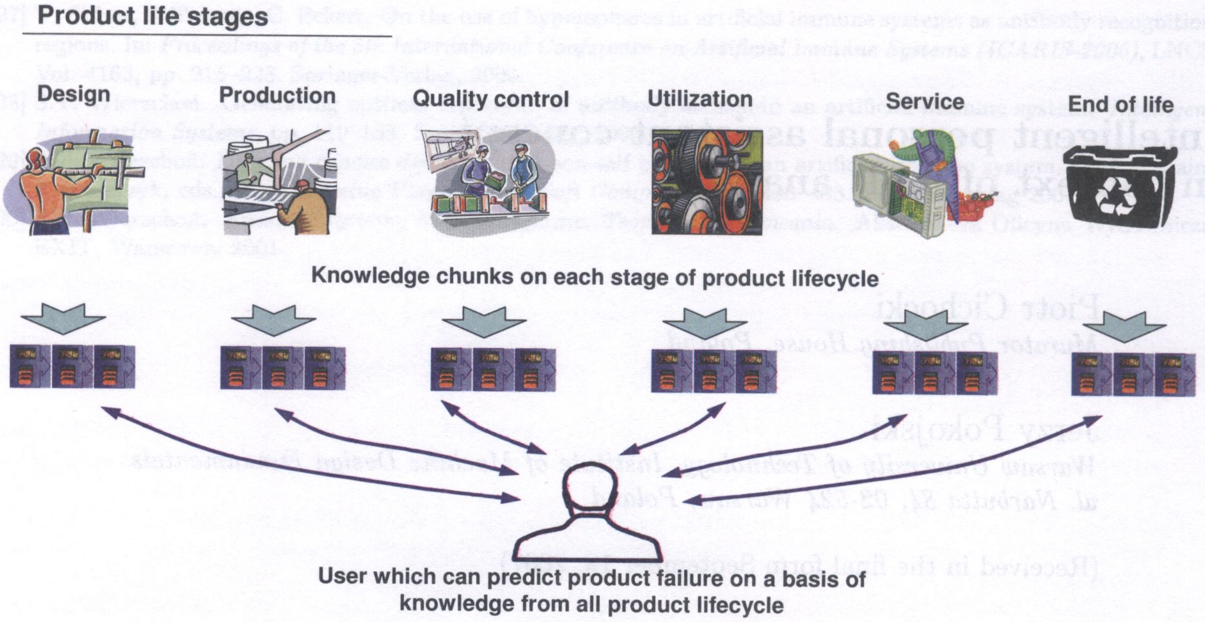


Fig. 1. Basic ideas of Aoyama's concept

documentation is forwarded to the production engineer who is at the same time the last instance for the quality of the product. Aoyama observed that many of the production faults in automotive industry (mass production) result from a lack of understanding among all the engineers who are involved in the whole production process. Concurrent Engineering has taken up that problem and is developing methods and approaches to deal with it [8, 30].

As production and design processes are becoming more and more complex a single engineer is hardly able to capture the intentions of his co-operators. The question is, at what step of the production is mutual understanding most necessary. Probably it would be of an advantage at every step of the co-operation but this cannot always be realized. In real life partial solutions are met which are developed for particular problems [7, 8, 20, 21, 27, 29–31].

Aoyama shows in his works that the documentation of design intents while designing proves to be very helpful. He proposes a very efficient integration of the design process — modeled in a CAD/CAE system — with its actual design rationale layer. If every designer was equipped with this kind of support we could easily spot production faults by penetrating the intention depots of different engineers. With the help of this tool we may be enabled to comprehend the key mechanisms of how faults are generated.

The authors of this paper took up Aoyama's concept and linked it with the ideas of the designer's IPA (Intelligent Personal Assistant) [23–26]. In many cases it is not sufficient to analyze the engineer's intent depot when trying to explain the origin of a fault. Often computer models are built or real experiments are done with which the considered classes of problems can be analyzed better [6, 16, 18, 19, 22, 28]. The IPA concept was expanded for the process of building computer models and stands for the fault analysis. However, the authors don't consider practical organizational issues for enterprises. But all these works would not have been possible without Aoyama's preliminary concept of fault investigation.

2. IPA IN DESIGN AND MANUFACTURING

The coming into being of a product is determined by its preceding design process. Every design process on the other hand is based on knowledge which naturally accompanies every design activity performed by a human [8, 12, 23, 30]. The knowledge is created and accumulated by people.

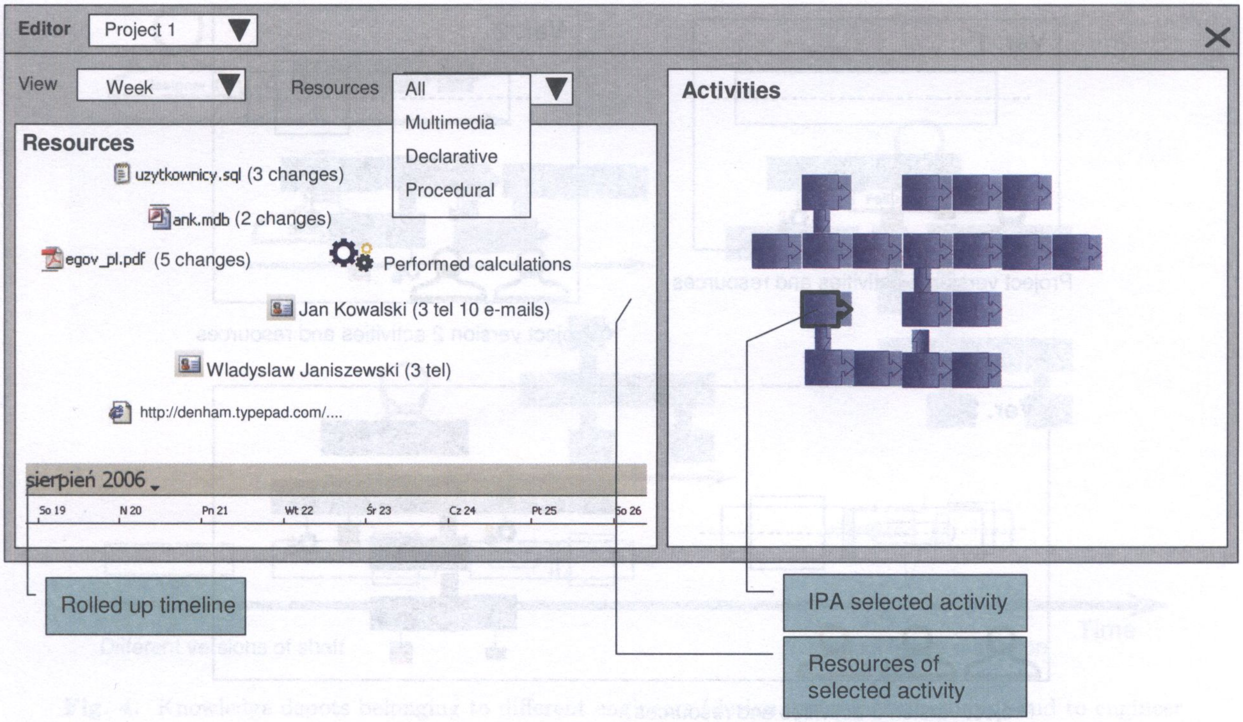


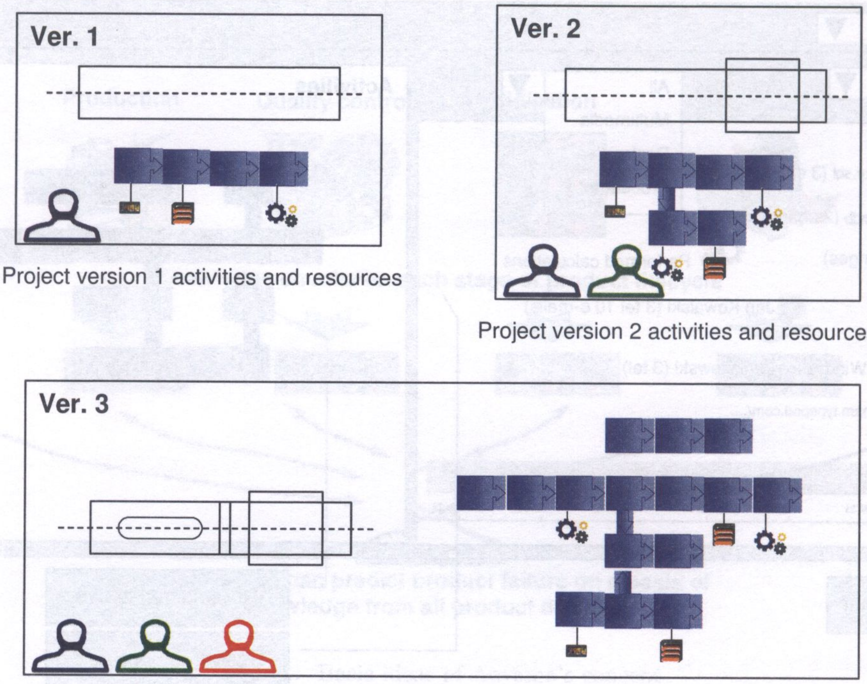
Fig. 2. Exemplary activities and resources belonging to engineer's personal depot

Each design activity can cause a knowledge increase, i.e. a new knowledge chunk. Designers mostly associate their often dynamically evolving knowledge with concrete activities or with certain plans of the design process. When working, the engineers establish their plans on the basis of activities which they are able to perform and which they are familiar with. The arising knowledge is expressed in different forms – representations. But not every kind of knowledge can be represented formally. Apart from that the knowledge exploited in design processes may come from various sources. The sources also may be clearly structured such as books or fixed standards or rather assembled without form as personal contacts, conversations, experiences and associations. What all these knowledge chunks have in common is their source of inspiration as well as connections and associations with other knowledge elements. The already existing attempts of building depots for the designer's knowledge are mostly structured on the basis of the designer's activities [23]. As a rule the recordings are supported by representations which are used to model the development of personal knowledge. Often they are joined to the repository of the realized project. In most cases this is realized as a connection between the IPA resources and the design process events. In this case we are able to assign each activity to the parts of the project which were realized by applying the content of the respective activity. Obviously, we can also do it the other way round and analyze through which activity a particular stage of the project was performed. After that the product development can be reflected in the product documentation and in the IPA resources (Fig. 2) connected to it.

Because the activities are rarely carried out spontaneously but rather develop slowly from project to project (Fig. 3) makes this approach especially advantageous. If we want to delve into a part of the project we can re-use old explanations or can make new more advanced versions of them. The IPA resources will then be able to trace the personal knowledge development.

The IPA concept in question can be used to build a software which meets with the functions mentioned above. It is also possible to equip it with other methods and tools such as case based reasoning [23], ontologies and their processing units [9, 11, 13, 29, 31], for example.

Below the approach is elucidated with the example of a machine shaft design. The set of usually performed activities in such a process is as follows:



Project version 1 activities and resources

Project version 2 activities and resources

Project version 3 activities and resources

Fig. 3. Exemplary performed activities and their resources

- initial data selection,
- static calculations,
- form giving for different shaft components,
- strength calculations,
- dynamics calculations,
- eliminating typical faults.

Figure 3 depicts how the activities of the above list were integrated with the selected knowledge sources which supported the various design activities. The graphic interface also makes clear what other projects were realized earlier and when, and shows their connections to the particular versions of the designer's actual activities. In a similar way we can visualize other aspects of the machine shaft design process.

Next we want to focus on the process of preparing a plan for the shaft manufacturing for which an IPA system is exploited as well. The stored activities and their respective knowledge resources are the following:

- selection of material,
- selection of manufacturing operations,
- establishing a plan for the manufacturing operations,
- development of individual structures of each operation,
- selection of tools and machines.

Figures 3 and 4 show the different activities together with their knowledge backgrounds. The exemplary project documentation and its IPA resources are presented as well.

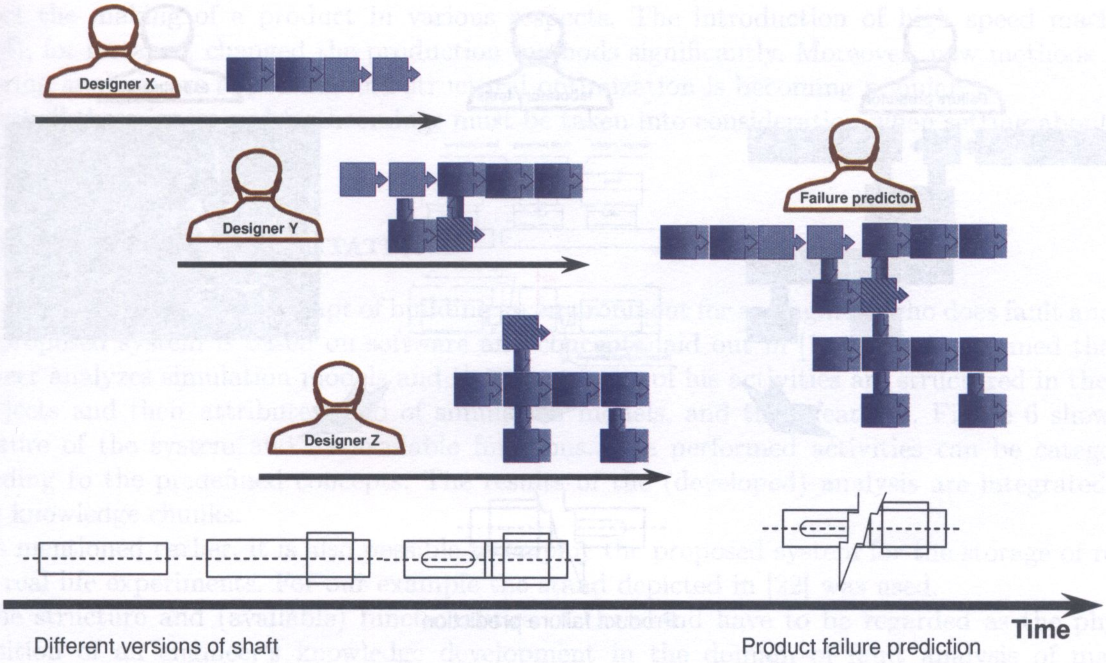


Fig. 4. Knowledge depots belonging to different engineers (design, manufacturing, etc.) and to engineer making fault analysis

The design process of the shaft is integrated with the establishing of its manufacturing plan. This integration is at least in so far realized as the design documentation is handed over to the engineers in charge of the manufacturing plan. Later the whole documentation is used by the production engineers. They then decide about the detail procedures and their realization. These engineers also obtain knowledge with its own development.

Now we can imagine the situation that all preparation works are done, the production is in progress and shafts are produced. But the shafts turn out to be faulty. In case of simple geometric faults it is relatively easy to find their cause. But in the case of dynamic vibrations, for instance, the cause is not necessarily clear. The designers as well as the engineers concerned with the production may be responsible for the fault; or even all of them at different degrees. To find the black sheep is a rather difficult undertaking. For that purpose an expert is needed who can obtain the knowledge of all the engineers involved in the process. In the case of the shaft production it might be even possible to find such a person but with more complex products it would be improbable because the wealth of knowledge required for that situation would exceed the abilities of a single human. A way of getting to the bottom of the problem would require searching and analyzing the designer's and engineers' personal knowledge depots. When being successful, the engineer investigating the faults explains his conclusions as hypothesis which then has to be verified. The verification can either be done by computer modeling and computer experiments or by real life experiments. Regarding the wide spectrum of activities which the engineer interpreting the faults has to perform, the idea to apply the IPA approach for that purpose seems to suggest itself (Fig. 4).

3. THE IPA IN FAULT INVESTIGATION PROCEDURES

The idea to employ the contents of the IPA resources of all engineers participating in industrial processes for the investigation (the designing and production of a product) of faults seems to be appropriate. And there are many different ways (Fig. 5) to explore the available sources. In the given example of the shaft the dynamic vibrations may result from geometric faults in the production, from wrong machine adjustments, manufacturing processes (for instance different axis in each operation), missing analysis of shaft dynamics and others. If the investigation of the IPA content doesn't show

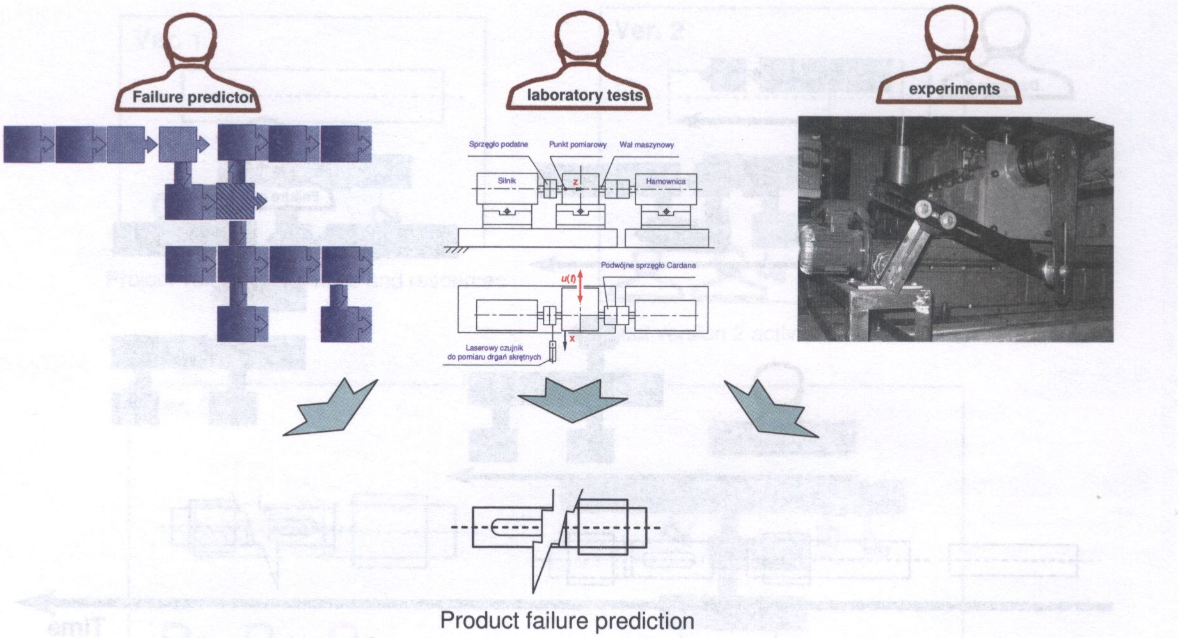


Fig. 5. Knowledge and tools available for engineer making fault analysis

definite results, which means a clear reason for the fault, we have to make a kind of analysis on the basis of selected models. Nowadays most of the models in industry are multi-disciplinary [23, 26]. Because of that we have to integrate the respective disciplines for the fault examination process. In our case computer models of shaft dynamics using a multi-body formalism must be joined with software for simulating turning processes in manufacturing. To perform such activities knowledge is needed. This knowledge again may be personal, stored in IPA resources and as such integrated with projects in which the reasons for the faults were analyzed.

The entire knowledge about fault can be structured as follows [2–6]: components, failure mode, physical phenomena, causes, impacts and measures. We can consider phenomena which became obvious at the moment when the fault was discovered [2–6] and integrate this information with models which were considered at the moment of analyzing. After that the different details of the performed analysis — model parameters, partial and final results — can be stored. Both, results and parameters may be categorized afterwards.

In most analyses of this kind the whole procedure does not end in one iteration. Models are corrected and improved or replaced by new ones [23, 26]. So an evolution of the models can be observed. With the help of an IPA environment it is possible to capture this process and its knowledge development.

The knowledge development of a fault analysis can also be implemented in the case of using an experimental stand.

4. FAULT ANALYSIS AND THE ISSUE OF KNOWLEDGE DEVELOPMENT

The laid out scheme of integrating an IPA concept with fault analysis works only on the condition that the person using it understands the complete process which brought about the false product. So before embarking on the analysis of faults we should endeavor to understand what other engineers performed before a product came into being. This requires a lot of effort as the development of products accelerates and their complexity increases.

In mechanical engineering, for example, mechatronics is strongly advancing and influencing design processes (integration of classical mechanical engineering with hardware and software developments). Additionally, the use of new materials has become standard. Their features also strongly impact the making of a product in various respects. The introduction of high speed machining (HSM), for instance, changed the production methods significantly. Moreover, new methods in engineering analysis are appearing and structural optimization is becoming popular.

And all these issues and forthcomings must be taken into consideration when setting about fault analysis (Fig. 5).

5. EXEMPLARY IMPLEMENTATIONS

This chapter presents the attempt of building an environment for an engineer who does fault analysis. The proposed system is based on software and concepts laid out in [1, 19]. It is assumed that the engineer analyzes simulation models and that the results of his activities are structured in the form of objects and their attributes, and of simulation models, and their features. Figure 6 shows the structure of the system and its available functions. The performed activities can be categorized according to the predefined concepts. The results of the (developed) analysis are integrated with other knowledge chunks.

As mentioned earlier, it is also possible to employ the proposed system for the storage of results from real life experiments. For our example the stand depicted in [22] was used.

The structure and (available) functionalities of the stand have to be regarded as the physical exposition of an engineer's knowledge development in the domain of fault analysis of machine shafts. The concepts applied for the stand are rather classical [22]. The system enables the user to analyze the history of the realized experiments and functions which are available as well while supporting a specific searching. The results can be visualized with the help of the search and filter functionalities [19]. The system is also equipped with integration capabilities with which its content can be exported or imported.

Applying ontologies and their tooling are an approach often met with today's generation of knowledge based systems [1, 9, 11, 14, 17]. Figure 7 shows an attempt of knowledge modeling in the ActiveKB system [1]. The modeled knowledge can be represented either formally or informally. Hierarchic structures and links are available too. Several functionalities of the system are realized automatically (searching, forming connections).

The authors also developed a new so-called time-line concept of the user's interface for the IPA system [25]. It offers the possibility of exploring system resources along the time axis; visualized with a time-lapsed axis.

6. CONCLUSION

While working on the problem of employing the IPA for fault analysis the authors came to the idea of using the IPA parallel to the product design and the development of the manufacturing process. Consequently, the presented concept represents one integrated approach which is able to realize many data and knowledge flows.

The exemplary part of the paper, however, is limited to the support of several selected activities only. But it is possible to extend it, so that it can support the design process of a shaft when new materials are introduced – either for the shaft itself or for the body covering. As a consequence the manufacturing process is prepared for the HSM technology.

It would be a very challenging task to model the personal knowledge development in IPA structures for somebody who has designed shafts, analyzed shafts and also designed and developed experimental stands for the fault analysis of shafts. With several such "biographies" we would surely be able to understand knowledge development in real life engineering better.

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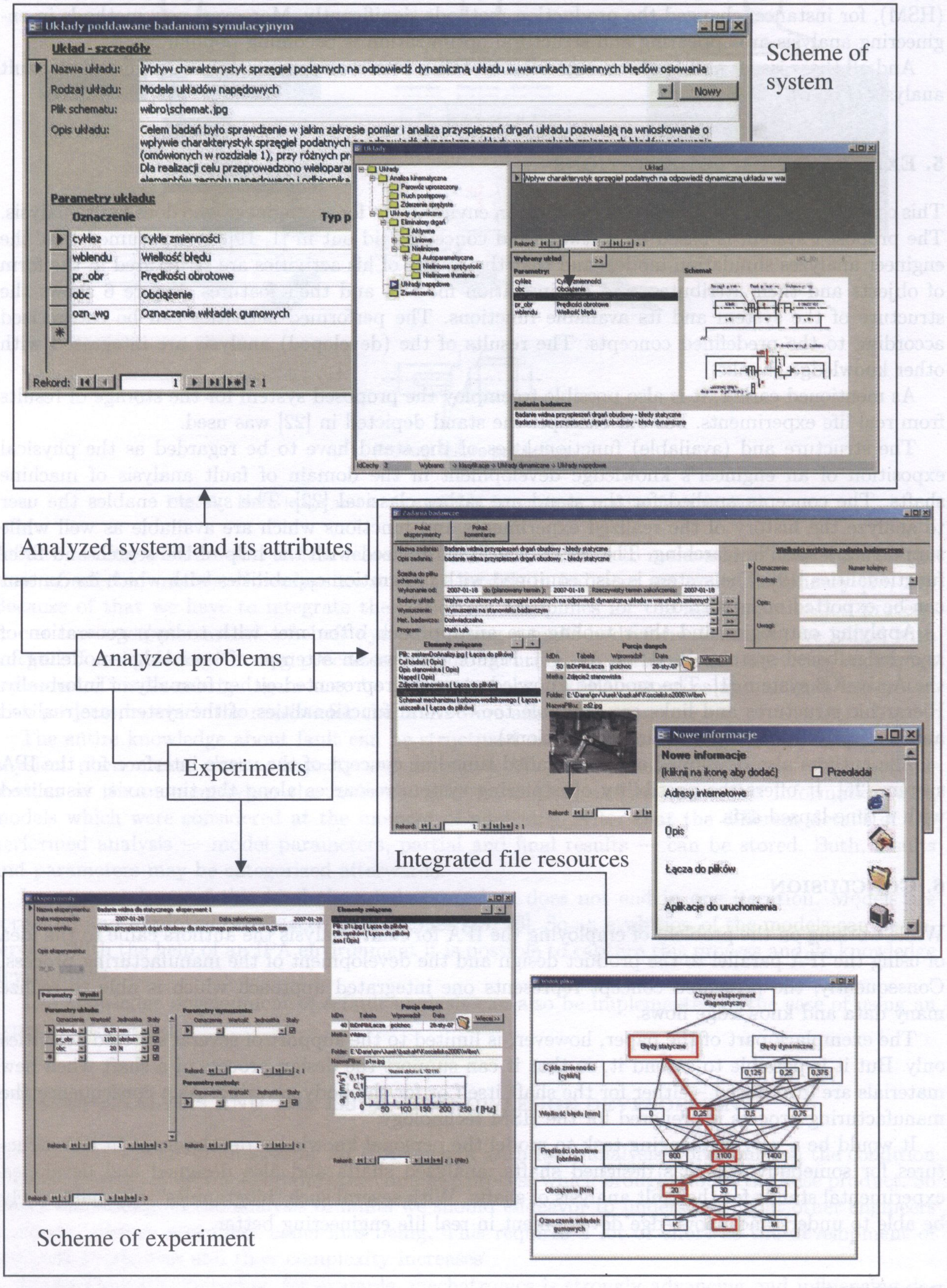


Układy poddawane badaniom symulacyjnym

Układ - szczegóły

Nazwa układu: Wpływ charakterystyk sprzęgieł podatnych na odpowiedź dynamiczną układu w warunkach zmiennych błędów osiowania

Rodzaj układu: Modele układów napędowych

Plik schematu: wibro\schemat.jpg

Opis układu: Celem badań było sprawdzenie w jakim zakresie pomiar i analiza przyspieszeń drgań układu pozwalają na wnioskowanie o wpływie charakterystyk sprzęgieł podatnych (omówionych w rozdziale 1), przy różnych pr Dla realizacji celu przeprowadzono wieloparar

Parametry układu:

Oznaczenie	Typ p
cyklez	Cykle zmienności
wblendu	Wielkość błędu
pr_obr	Prędkości obrotowe
obc	Obciążenie
ozn_wg	Oznaczenie wkładek gumowych

Rekord: 1 z 1

Układy

Układ: Wpływ charakterystyk sprzęgieł podatnych na odpowiedź dynamiczną układu w wa

Wybrany układ

Parametry:

cyklez	Cykle zmienności
obc	Obciążenie
pr_obr	Prędkości obrotowe
wblendu	Wielkość błędu

Schemat

Zadania badawcze

Badanie widma przyspieszeń drgań obudowy - bledy statyczne
Badanie widma przyspieszeń drgań obudowy - bledy dynamiczne

IdCechy 3 Wybrano: -> klasyfikacje -> Układy dynamiczne -> Układy napędowe

Zadania badawcze

Nazwa zadania: Badanie widma przyspieszeń drgań obudowy - bledy statyczne

Opis zadania: badanie widma przyspieszeń drgań obudowy - bledy statyczne

Ścieżka do pliku schematu:

Wykonanie od: 2007-01-18 do (planowany termin): 2007-01-18 Rzeczywisty termin zakończenia: 2007-01-18

Badany układ: Wpływ charakterystyk sprzęgieł podatnych na odpowiedź dynamiczną układu w warunkach zmiennych

Wymuszenie: Wymuszenie na stanowisku badawczym

Met. badawcza: Doświadczalna

Program: Math Lab

Wielkości wyjściowe zadania badawczego:

Oznaczenie: Numer kolejny: Rodzaj: Opis: Uwagi:

Elementy związane

Plik: zestawDoAnalizy.jpg (Łącza do plików)
Cel badań (Opis)
Opis stanowiska (Opis)
Napęd (Opis)
Zdjęcie stanowiska (Łącza do plików)
Schemat mechanizmu korbowo-wodzikowego (Łącza
uszczelka (Łącza do plików)

Porcja danych

IdDn	Tabela	Wprowadził	Data
50	tbDnPlikiLacza	pcichoc	28-sty-07

Metka: Zdjęcie2 stanowiska

Folder: E:\Dane\prv\Jurek\bazkaM\Koscielisko2006\Wibro\

NazwaPliku: zd2.jpg

Rekord: 1 z 1

Nowe informacje

Nowe informacje

(kliknij na ikonę aby dodać) ☐ Przeglądaj

Eksperymenty

Nazwa eksperymentu: Badanie widma dla statycznego eksperyment 1

Data rozpoczęcia: 2007-01-28 Data zakończenia: 2007-01-28

Ocena wyniku: Widmo przyspieszeń drgań obudowy dla statycznego przesunięcia osi 0,25 mm

Opis eksperymentu:

Parametry układu:

Oznaczenie	Wartość	Jednostka	Stały
wblendu	0,25	mm	☑
pr_obr	1100	obr/min	☑
obc	20	N	☑

Rekord: 1 z 3

Parametry wymuszenia:

Oznaczenie	Wartość	Jednostka	Stały
			☑

Parametry metody:

Oznaczenie	Wartość	Jednostka	Stały
			☑

Elementy związane

Plik: p1s.jpg (Łącza do plików)
Plik wyników (Łącza do plików)
aaa (Opis)

Porcja danych

IdDn	Tabela	Wprowadził	Data
40	tbDnPlikiLacza	pcichoc	28-sty-07

Metka: Widmo

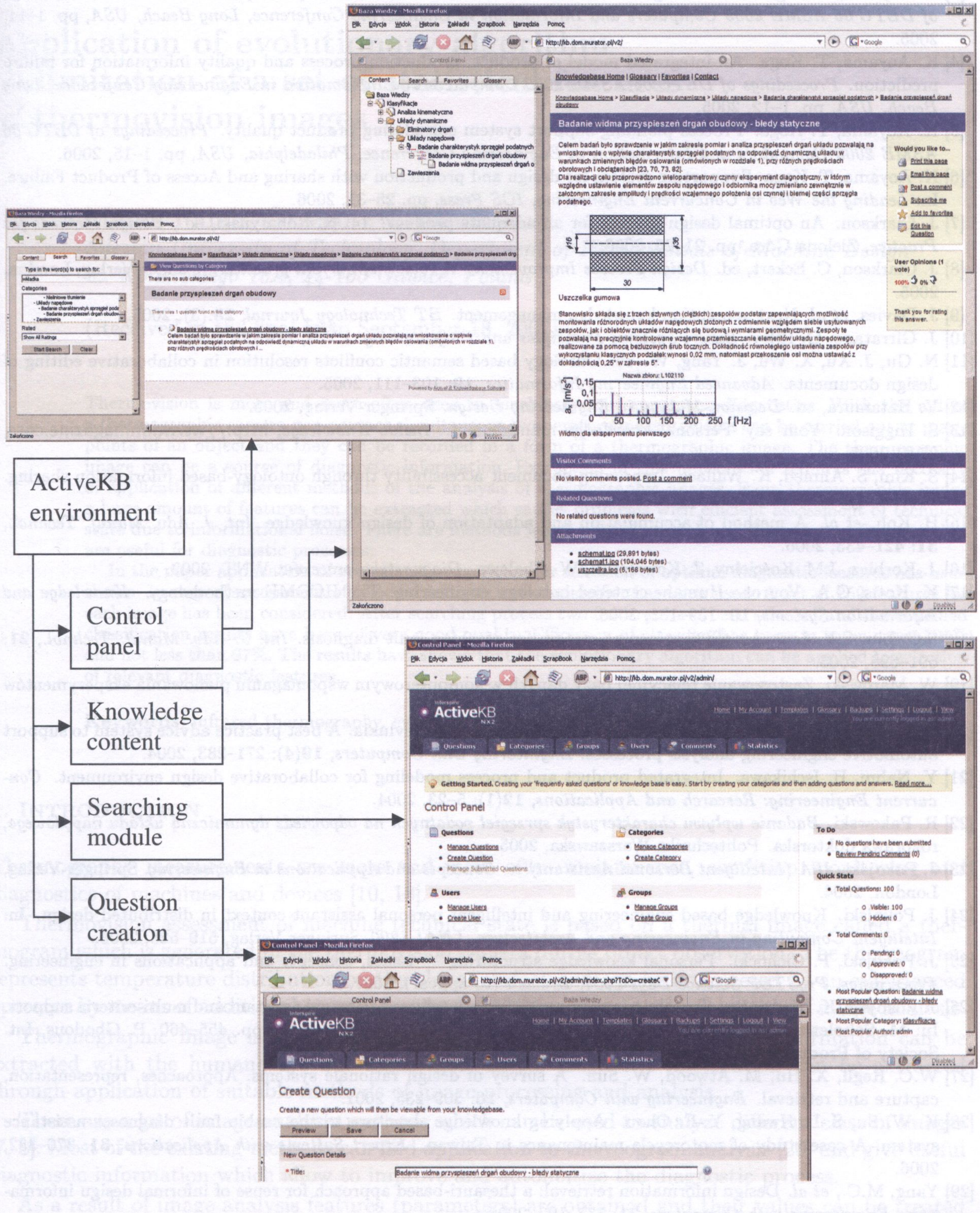
Folder: E:\Dane\prv\Jurek\bazkaM\Koscielisko2006\Wibro\

NazwaPliku: p1w.jpg

Rekord: 1 z 1 (Filtr)

Widok pliku

Fig. 6. Basic system structures and functionalities



Knowledgebase Home > Klasyfikacje > Układy dynamiczne > Układy napedowe > Badanie charakterystyk sprzegieł podatnych > Badanie przyspieszeń drgań obudowy

Badanie widma przyspieszeń drgań obudowy - błedy statyczne

Celem badań było sprawdzenie w jakim zakresie pomiar i analiza przyspieszeń drgań układu pozwala na wnioskowanie o wpływie charakterystyk sprzęgieł podatnych na odpowiedź dynamiczną układu w warunkach zmiennych błędów osiowania (omówionych w rozdziale 1), przy różnych prędkościach obrotowych i obciążeniach [23, 70, 73, 82].
Dla realizacji celu przeprowadzono wieloparametrowy czynny eksperyment diagnostyczny, w którym względne ustawienie elementów zespołu napędowego i odbiornika mocy zmieniano zewnętrznie w założonym zakresie amplitudy i prędkości wzajemnego położenia osi czynnej i biernej części sprzęgła podatnego.

Uszczelka gumowa

Stanowisko składa się z trzech sztywnych (ciężkich) zespołów podstaw zapewniających możliwość montowania różnorodnych układów napędowych złożonych z odmiennie względem siebie usytuowanych zespołów, jak i obiektów znacznie różniących się budową i wymiarami geometrycznymi. Zespoły te pozwalają na precyzyjnie kontrolowane wzajemne przemieszczanie elementów układu napędowego, realizowane za pomocą bezluzowych śrub tocznych. Dokładność równoległego ustawienia zespołów przy wykorzystaniu klasycznych podziałek wynosi 0,02 mm, natomiast przekoszenie osi można ustawiać z dokładnością 0,25° w zakresie 5°.

Nazwa zbioru: L102110

Widmo dla eksperymentu pierwszego

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No visitor comments posted. Post a comment

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- schemat.jpg (29,891 bytes)
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- uszczelka.jpg (6,168 bytes)

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New Question Details

Title: Badanie widma przyspieszeń drgań obudowy - błedy statyczne

Fig. 7. ActiveKB environment and its basic components

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