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# PROPERTIES OF THE COLLABORATIVE SYSTEMS METRICS

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**Abstract.** The paper describes the key properties of the collaborative systems. There are presented main quality characteristics for the collaborative systems. The paper analyzes different types of indicators. They represent the base for further metrics definition. There are described the indicators most important characteristics as sensitivity, non catastrophic, non compensatory and representatives.

## 1. INTRODUCTION

A collaborative system is one where multiple users or agents are engaged in a shared activity, usually from remote locations. In the large family of distributed applications, collaborative systems are distinguished by the fact that the agents from the system are working together towards a common goal and have a critical need to interact closely with each other.

The informatics collaborative system is like a distribution firm that has the objective to sell more and more quantities of their products and for that has commercial agents, which go to various retail shops in order to convince them to close a distribution contract.

The properties of the collaborative systems are an important subject of our days, and an important part of the human activities is involved in this problem. The complexity of this subject, but also the huge number of the applications makes impossible to have a large presentation in a note, but we would underline some of the main aspects.

Collaborative systems represent a new interdisciplinary domain at the intersection of economics, computer science, management, sociology, etc. From the implementation viewpoint, the collaborative systems represent software entities that are developed during a life cycle process that starts with the problem analysis and ends with the implementation of a fully functional software system. Implementing a collaborative system is accomplished using software instruments that allow the development of distributed software applications.

Science has great impact on the development of different types of collaborative systems from various activity fields. The medical field in which modern communication technologies allow doctors from around the world to work on the same patient gives one important domain that was one of the first fields presenting great interest in implementing complex collaborative systems. In a chirurgical operation each person from the group of doctors has distinct roles. In this example it is analyzed a collaborative system model representing a training on different chirurgical activities that is done in a virtual medium. The training is based on the scenario in which the instructor and the trainee are on different locations. The instructor and the trainee share a common virtual space that contains various three-dimensional anatomical models. Each person interacts with the other one through the virtual space and a medical simulation engine describes the physical and logical behavior of objects present on the virtual scene. The interaction is maintained by a multi-modal interface that uses visual 2D and 3D data, voices and audio simulation. Each person is in front of a working table that has a monitor and stereo active pair of glasses.

All of these generate a three-dimensional desktop. For collaborative use, it has been implemented a mini broadband system that allows creating a videoconference between persons.

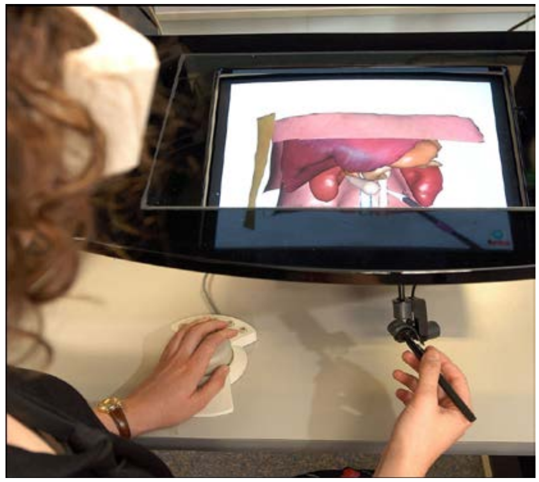

**Fig. 1.** Collaborative system model representing training on different chirurgical activities *[STEV05]*

The interaction between the instructor and the trainee is based on voice, gestures and chirurgical demonstrative actions, step-by-step tutorial and simultaneous actions.

The chirurgical training from this example, suppose a high level of interaction between the two persons. In opposition with training systems developed only for chirurgical dexterity, this process is concentrated also on procedures that target the understanding of the patient anatomy. The learning process is enhanced by the demonstration, the dialog and the show how activities.

### *2. THE QUALITY CHARACTERISTICS SYSTEM FOR COLLABORATIVE SYSTEMS*

The collaborative systems represent, from the implementation viewpoint, software entities that are developed during a life cycle process that starts with the problem analysis and ends with the implementation of a fully functional software system.

The quality is a main characteristic of a collaborative system and contains the followings properties: maintainability, reliability, efficiency, usability, portability and functionality.

This characteristic may be analyzed also from the viewpoint of the length of the track the message is taking from the source component to the destination one. On this way, the system must take care the messages are not lost in the system or they aren't altered.

When for each quality characteristic $C_1, C_2, \ldots, C_n$ are established the normal areas in which are enclosed, delimited like subintervals $[b_i, 1]$ with $0 < b_i < 1$, $i=1..n$, on represent on the nomogram the standard diagram of the collaborative system functionality:

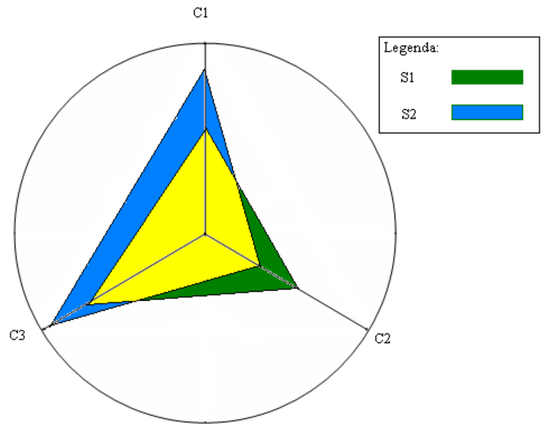


**Fig. 2.** The standard diagram for the functionality of a usual collaborative system

Is defined below the indicator ***HS*** like:

$HS = \frac{S_1}{S_2}$, where $S_1$ and $S_2$ are the surfaces delimited in the figure 2.

If ***HS = 0***, then the collaborative system is working properly and very well and if ***HS = 1***, the collaborative system is working very bad.

The most important quality characteristics for the collaborative systems are enumerated below:

***C₁*** *– complexity;*
***C₂*** *– structurability;*
***C₃*** *– stability;*
***C₄*** *– adaptability;*
***C₅*** *– operationality;*
***C₆*** *– integrability.*

All the indicators associated with these characteristics are defined with values from the interval [0;1]. Experimentally, was established the following intervals:

*[0; 0,78)* – the interval in which the collaborative system is working unsatisfactorily for the characteristic $C_i$, ***i=1..6.***

*[0,78; 0,92]* – the interval in which the collaborative system is working well for the characteristic $C_i$, ***i=1..6.***

*(0,92; 1]* – the interval in which the collaborative system is working very well for the characteristic $C_i$, ***i=1..6.***

### *3. THE QUALITY INDICATORS*

The main quality indicators of the collaborative systems are the indicators like complexity, reliability, portability and maintainability.

The complexity is a measure for the interdependencies between components and their links and also for the diversity of different types of input and output constructions. This characteristic describes the density of fluxes between the components of the system.

The McCabe complexity was implemented with the next formula:

$CC = n_a - n_n + 2$, where:

- $n_a$ is the number of relations between the components of the collaborative system;
- $n_n$ is the number of collaborative system components.

The system reliability is determined by analyzing the number of problems solved by the system and the total number of specified problems.

The reliability for the software component of a collaborative system is defined like:

$$I\ fiab = \frac{r\ succes}{r\ total}$$ , where:

- *I fiab* is the reliability indicator;
- *r succes* is the number of successfully executions of the program
- *r total* is the total number of program executions.

System reliability is a very important quality indicator because:

- it value is directly determined by the number of processes and activities that give correct and complete results;
- allows particular approaches for determining models of quality estimation; taking into consideration the hypothesis that once the causes that generates unwanted errors and system failures are eliminated it is possible to increase its levels and directly the system quality;
- its value influences the entire collaborative system project;

The portability for the software component of a collaborative system is:

$$G\ portab = 1 - \frac{LA + LM + LE}{LI}$$ , where:

- *G portab* is the portability degree indicator;
- *LA* represents the number of added instructions;
- *LM* represents the number of modified instructions;
- *LE* represents the number of instructions eliminated from the program;
- *LI* represent the total number of program instructions;

The maintainability of a collaborative system is defined like:

$$I\ ment = \frac{T\ modif}{T\ dezv}$$ , where:

- *I ment* is the maintainability indicator;
- *T modif* represent the necessary time for the realization of the modifications in the system in order to keep them in current use;
- *T dezv* is the necessary time for the system development.

The maintainability is a process particular to software products that have a complex development process and that are intended to be used for a long time, meaning more than three years. In this category are included also products like the collaborative systems.

The quality-aggregated indicator for a collaborative system is defined like:

$$I_{calit} = \frac{\min(A,B)}{\max(A,B)} * p + \frac{\min(X,Y)}{\max(X,Y)} * q$$ , where:

- *A* is the level of the planned quantity;
- *B* is the level of the realized quantity;
- *X* is the level of the planned quality;
- *Y* is the level of the realized quality;
- *p* represent the percentage of quantitative characteristics and has, generally, the value 0,4;
- *q* represent the percentage of qualitative characteristics and has, generally, the value 0,6.

## *4. THE INDICATORS PROPERTIES*

The analytical forms of the indicators must be built such as the indicators simultaneously assure the following conditions. They must be:

- *sensitive*, that is at small variations of the influence factors the result variable has small variations; at big variations of the influence factors the result variable has big variations;
- *non-compensatory*, that is at different variation sets of the factors, small values of the result variable are not obtained;

- *non-catastrophic*, that is at small variations of the factors, big variations of the result variable have not to obtain;
- *representative*, it represents the quality to be accepted by users in analysis making assuring the significance of the results.

The analytical form of an indicator used to measured quantitative levels for collaborative systems qualitative characteristics is based on

$$y = f(x_1, x_2, \ldots, x_{nfc}),$$

where:

***nfc*** – number of identified factors which have impact on the evolution of analyzed phenomena;
$x_i$ – measured level for the $i^{th}$ influence factor of the case study;
***f( )*** – an analytical real form used to represent the dependency between the influence factors and result variables; it is used to describe and to study the phenomenon;
***y*** – result variable that describe an existing situation in the phenomenon evolution.

In case of the type **I** indicators, which have analytical forms as:

$$I = \frac{A}{B},$$

the catastrophic character is the result of the very high variation of metrics value while the value of B factor is converging to zero.

The indicator $K_T = N_1 log_2 N_1 + N_2 log_2 N_2$ is sensitive, because the variations from $N_1$ to $N_1' = N_1 + \gamma$, respectively from $N_2$ to $N_2' = N_2 + \Delta$ determines:
$K_T' = N_1' log_2 N_1' + N_2' log_2 N_2' = (N_1+\gamma) log_2(N_1+\gamma) + (N_2+\Delta) log_2(N_2+\Delta) =$
$N_1 * log_2(N_1+\gamma) + N_2 * log_2(N_2+\Delta) + \gamma * log_2(N_1+\gamma) + \Delta * log_2(N_2+\Delta) > K_T + \gamma * log_2(N_1+\gamma) + \Delta * log_2(N_2+\Delta)$

In the case of **n** variables $x_1, x_2, \ldots, x_n$, a generalized indicator for collaborative systems are:

$$I_n = f(x_1, x_2, \ldots, x_n) = \frac{\min\{x1, x2, \ldots, xn\}}{\max\{x1, x2, \ldots, xn\}}$$

For this indicator, the maximal value are **1** when $x_1=x_2=\ldots=x_n$, with the condition that $x_i>0$, **i=1..n.** The sensitive property for this indicator are verified, but the non-compensatory property is not verified, because at different variation sets of $x_1, x_2, \ldots, x_n$ factors, the $I_n$ value is the same.

The indicator is sensitive in case in which the levels associated to the influence factors have a variation such as it obtains the same general type of variation for the analyzed collaborative system.

### *5. CONCLUSIONS*

The field of collaborative systems is a domain that has many published papers and that has acquired in the last period a great volume of theoretical knowledge. This provides the methods and techniques to analyze the problem, to identify the resulting variables, the influence factors and in the end to define the model.

The properties of the collaborative systems metrics have great impact on the number of factors and as result on the scale of the model. In the end, it must be reached equilibrium between the model dimension and its capability to give significant results. The metrics must be not too complicated because it will use lots of resources when implemented and also it must be not too simple because the measured levels will loose relevance.

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