MODEL OF RESISTANCE DYNAMICS IN THE CHANGE PROCESS

*Zbigniew Wiśniewski**

Abstract

Background. The article presents the findings of the study on change process dynamics. It is assumed in the model that particular elements of organization help to form systems. These systems, like all others, are subject to certain regularities: they generate output signals based on the level and dynamics of input signals. Yet the system has static and dynamic characteristics i.e. the type of function transforming input into output is the most important feature of the system. Knowledge of the system's characteristics and the course of input signals gives a possibility to try and determine the value of output signals. Knowledge of a specific system's characteristics can enable not only the prediction of its behaviour but also the application of a regulatory system, so that the output parameters maintain certain properties established in advance, regardless of the state of inputs.
Research aims. The aim of the conducted research was to identify the dynamic parameters of objects which are subject to changes.
Method. Registering of the effects and reactions to the changes was performed for selected (single-person) work stations and groups of workers. It involved observation of the progress of normal organisation processes in a real socio-information-technical environment.
Key findings. As a result, an organization subsystem model was developed for the subsystem which is undergoing changes. Knowledge of the dynamic parameters may allow for better change processes' control and thus for higher efficiency. The Author proposes an application of a specific approach to realization of the process of changes implementation on the operational level of management, called DBMCI (Dynamic–Based Model of Changes Implementation).

Keywords: Change management, Change dynamics, Change resistance

INTRODUCTION AND BACKGROUND

It can be observed that managers notice many different attitudes for resistance towards changes, starting from psychological ones and ending with technical ones (Austin, 1997; Carr, Hard & Trahant, 1998; Clarke 1997; Grouard & Meston, 1997; Stickland, 1998). Not questioning the above findings on the sources of problems that appear during implementation of changes, it is worth looking at the process of reacting to stimuli, for example the process of influencing a dynamic object with a specific structure: (a) memory, (b) inertia, (c) delay, (d) information, (e) energy and (f) emotional capacity. The foundations for this approach were laid by Mazur (1966, 1976), who provided a cybernetic model of human character. Implementation of changes can be considered a dynamic activity. It takes

* Dr hab. Prof. Zbigniew Wiśniewski, Lodz University of Technology.

place at a specific time interval, in which effects of unexpected character are triggered (which results from difficulties with accepting new, imposed operating conditions). The effects are hard to predict and caused by the dynamic character of organization elements. Dynamism means that reactions to stimuli depend not only on the level of the stimuli but also on the course of events up to that point and the effects caused by the stimuli. A lot of managers do not realize that in the transition period, i.e. till the moment of accepting and stabilizing the effects after the implementation of changes, the static relation between a stimulus and its result, which they used to know so far, does not occur. For example, the fact that an employee accepts the relation between the level of his/her salary and work efficiency expected from him/her cannot be treated as a rule determining the worker's behaviour during change of expectations from him or of payment conditions.

The aim of the research, the conclusions from which have been presented in the paper, was to identify dynamic properties characterizing the entities undergoing changes. The results can facilitate development of more efficient methods of changes implementation, based on knowledge of types of expected reactions during the process of changes. The research was carried out under a research grant financed by the Polish Ministry of Science and Higher Education.

METHOD

The efficiency of processes was defined as a capability of achieving objectives with an assumed effectiveness, which in turn depends on the appearance of negative dynamic phenomena assisting the change. The phenomena build up the original way of describing the mechanism of changes, and they are defined in the following way:

1. Statism – failing to achieve the assumed target level of an objective after completing the change process;
2. Delay – delay in taking up an action towards change;
3. Resistance – drop in the level of effectiveness below the input value, right after initiating the changes (the rule of counteracting, the will to maintain *status quo*);
4. Oscillations – fluctuations of the level of the achieved effect during implementation of change and exceeding the level of the assumed objective (with the following effect of realisation effectiveness lowering);
5. Inertia – slowing down of reactions to the stimuli.

Within the proper research a series of observations of changes processes were performed, during which parameters of the studied phenomena were registered, and an identification of dynamic properties was performed with the use of the process model. For describing the parameters and characteristics of phenomena the Laplace transform and the operational transmittance were used.

Researches on changes management and the realization of innovation processes indicate (Francik, 2003) that there exists a positive relation between a possibility of change process supervision and control, and its success. As an experiment, gradual implementations were introduced for a limited group which reduced the risk of failure. What followed, was that in the case of an innovative solution, involvement of less funds and process realization on a smaller scale had less significant consequences in the case of failure than implementation with no previous checking of methods or procedures. Moreover, there exists one more positive aspect of the previous study into the implementation environment on the basis of an experiment and its properties identification. Such that an activity is a prelude, during which a manager has a possibility to observe reactions and program means to be taken in the future for final implementation. Finally, there is yet another benefit, the crew getting partially acquainted with the intentions and resources to be taken, so the phenomenon of counteracting is subject to self-extinction.

Identification Method and Research Sample

Identification consists of collecting and processing experimental data for the purpose of complementing a mathematical model. The task of identification is a very important stage, because the accuracy of the known parameters of the model is decisive on how accurately the phenomena taking place in the system are represented. Moreover, the model should be universal to enable solving a wide range of problems appearing in the system (Bielińska, 1997).

The research was performed among fourteen organisations, including production and service providing enterprises, as well as one financial service organisation. They were foreign companies, joint ventures, and companies with domestic capital.

Registering the effects and reactions to the changes was an important part of the research. The registering was performed for selected (single-person) work stations and groups of workers. It involved observation of the course of normal organisation processes in a real socio-information-technical environment.

The registration and evaluation of the progress of changes in processes is difficult, and it is not easy to assess the influence of particular actions taken by managers in terms of effectiveness. The assessment of the results was performed on the basis of (Masłyk-Musiał, 2002):

1. Changes in work productivity;
2. Changes in work effectiveness;
3. Financial data analyses;
4. Quality indicators: (a) fraction of shortages, (b) process capability, (c) OEE (Overall Equipment Effectiveness – an indicator that enables determining of the capacity of technological equipment), and (d) RTY (Rolled Throughput Yield – probability that a single unit of a product will undergo the whole technological process, free from defects);
5. Logistic indicators;
6. Production indicators.

The application of measures and indicators based on the TQM concept seems to be a good way to assess the successfulness of change, its rate and radical character (Masłyk-Musiał, 2003, p.147). According to Mikołajczyk (2003) the use of "hard" economic measures can be limited to only some results of changes. An analysis method and a quantitative assessment of operation effects were performed in the proposed process. The effects, such as measurements, were properly identified and combined from the perspective of their priorities in a given implementation situation.

For the analysis of effectiveness and efficiency of changes realisation the rules of the proceeding assessment were adapted (Mikołajczyk, 2003, p.108):

1. Effectiveness and efficiency are estimated by comparing the results with the assumptions (objectives) made before the beginning of the process of changes;
2. In the effects assessment the same tools are used for collecting information and balancing methods before, as well as during, implementation.

During the process of analysing the progress of changes in a given enterprise the parameters were registered with the use of the method of collecting quantitative data about the state of processes. In some cases the methods were based on a system of automatic processes data collection (especially in cases of production operations or other operations of a transaction type using computer systems). The remaining cases required registering certain parameters by the worker performing the job or a process observer (Wiśniewski, 2006, 2007).

Furthermore, for changes assessment the measurements for statistic assessment of the level of processes quality were used. They derive from the quality supervision systems and originate from the SPC method (Statistical Process Control). The Sigma level of the process DPU, DPO, DPMO and process capability indicators: C_p, C_{pk}, P_p, P_{pk} were used (Dietrich & Schulze, 2000; Iwasiewicz, 1999).

RESULTS

Results of Dynamic Properties Identification

In accordance with the assumed concept, identifications of the features of subsystems of organisations were performed via analyses of the reaction of a given subsystem to the implementations of changes (enforcing). In all organisations taking part in the research the changes process was identified as a reaction to one of the types of standard stimulus. The observation of effects achieved by a given object was the basis for determining dynamic parameters of the analysed object.

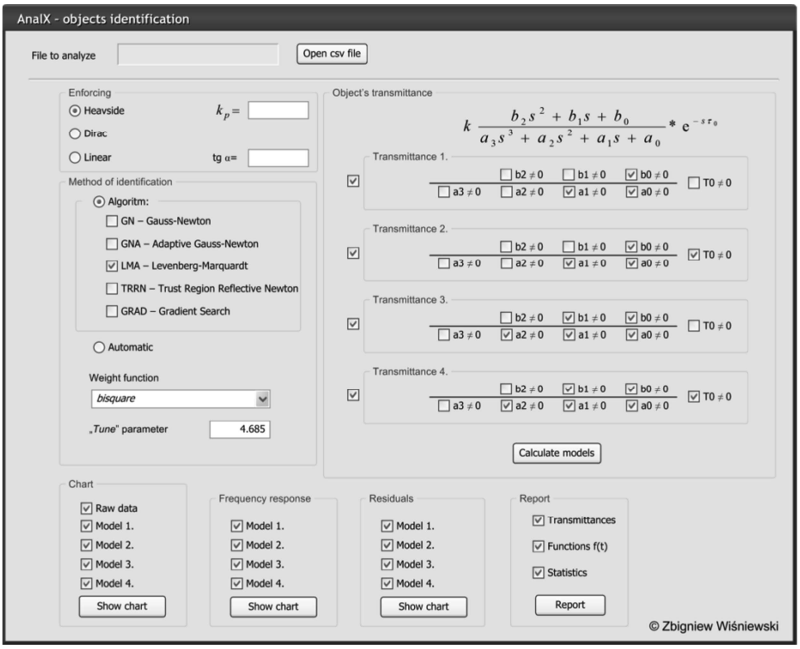

Figure 1. The View of the Main Panel from the Application for Identification

Source: (Wiśniewski, 2010).

The identification process was realised with the use of an application written in Matlab (Figure 1). As a result of its usage the equations of objects in time function and operational transmittances were obtained. Thanks to the above probable, dynamic models of each unit taking part in change implementation were determined.

Usually, a wide class of the models that are possible to describe with a transmittance are accepted for identification (Skoczowski, Osypiuk & Pietrusewicz, 2006, p.47):

$$G(s) = \frac{k\mathrm{e}^{-s\tau_0}}{\prod_{i=1}^{n}(1+sT_i)} \tag{1}$$

Due to the character of reaction to the objects under enforcing, the model has to be complemented with a possibility of oscillations occurrence and the resistance effect, i.e. counter reaction. As a consequence, imaginary roots are included in the denominator and the polynomial of a higher degree than m = 1 appears in the numerator.

The assumed calibrated model of an object to undergo identification has the form:

$$G(s) = \frac{b_2 s^2 + b_1 s + b_0}{a_3 s^3 + a_2 s^2 + a_1 s + a_0}\mathrm{e}^{-s\tau_0} \tag{2}$$

AnalX application is used for analysing the data obtained from observing the changes implementation processes, consisting in inflicting specific categories of stimuli on the observed objects. The application works upon the rule of a dialog with an analyst, supporting him/her mainly in performing complicated transformations and iterative algorithms.

Identification of objects under stimuli (implementation of changes) enabled the establishment of a dynamic model universal for the analysed categories of object. Its universal character results from the fact that operational transmittances obtained for all the objects can be brought down to a total transmittance having the following properties: (a) first order polynomial appears in the numerator, while the polynomial coefficient $b_1 \leq 0$ (further on referred to as T_3), (b) second order polynomial of real or imaginary roots appears mostly in the denominator, and (c) absolute term responsible for delay appears.

Now the total transmittance of the model has the form:

$$G(s) = k\left(\frac{T_3 s + 1}{T_0^2 s^2 + 2\zeta T_0 s + 1}\mathrm{e}^{-s\tau_0}\right) = kF(s)\mathrm{e}^{-s\tau_0} \tag{3}$$

In cases where overload and oscillations with meaningful resistance did not appear, mutually equivalent, different models with identically good adjustment to empirical data were obtained. The competitive models are the following:

$$G'(s) = k\left(\frac{1}{T'^2 s^2 + 2\zeta T' s + 1}\right) \tag{4}$$

$$G''(s) = k\left(\frac{1}{T'' s + 1}\mathrm{e}^{-s\tau_0}\right) \tag{5}$$

In the transmittance the denominator (4) contains real roots. The difference between both transmittances consists in the fact that the second-order inertia element (4) can be substituted by the first-order inertia element with a delay element (5). Due to analytical reasons, it has no bearing which of the models is taken into consideration for the synthesis of systems. Model (4) appears to be more universal, because it is possible to model more configurations of objects with its use under the condition that the appearance of imaginary root is acceptable. Nevertheless, it is a necessity in case of oscillation. On the other hand, it is postulated that the form of the models is brought to the lowest possible degree of denominator polynomial and replacing higher order inertia by delays (Halawa, 2007; Skoczowski et al., 2006, p.230).

Eliminating inertia for the benefit of simplifying the analytical form is still a redundant action, because it is always better to use a general model, which gives a possibility of identifying a wider range of cases. Limitation and excessive simplification of the model can lead to a reduction of the research resolution and a failure to notice singular cases (e.g. with oscillations). Anyhow the cases with resistance and oscillations are so clear that it is impossible to resign from the most universal model. It was decided that the general form be used (3) in which the delay element is implicated permanently. In such a case there will be no need to differentiate cases due to the model class at the identification stage. If it turns out that after calculating the model parameters they are characteristic for any of the simple elements, the ready transmittance equation can always be simplified. Yet it should not be done at the stage of model preparation.

The model of substitute transmittance (3) can be presented in the form of a block diagram (Figure 2).

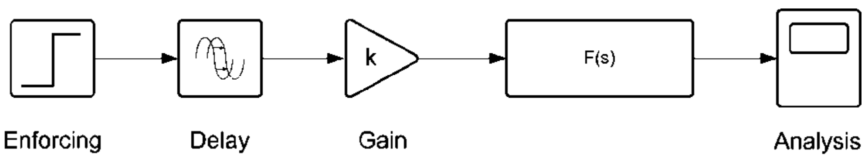

Figure 2. A block Diagram of the Object Under the Implementation of Changes

Source: (Wiśniewski, 2010).

The element in transmittance *F(s)* has been separated in order to show a possibility of applying alternative versions of models: with a delay or without it but with an additional inertia. Another unique feature of this class of objects is the fact that in practice a sound signal is additionally limited as far as the upper and lower values are concerned, which results from the conditions of real objects functioning so that they define minimum and maximum levels of reaction (effectiveness).

In order to better understand the dependencies occurring in real objects and the relations between the identified parameters and the structure of relations inside an object, it is worth considering the inner structure of the element and transmittance *F(s)*. The fact is that the existence of a non-zero coefficient T_3 indicates the existence of a differential element inside the object structure, negatively coupled with the rest of the elements. A practical consequence of this state is the appearance of the phenomenon of resistance. Resistance appears as counteracting an inflicted enforcing. The phenomenon was broadly described in the literature dealing with management and changes management (Baugier & Vuillod, 1993; Cameron & Quinn, 2003; Carr et al., 1998; Clarke, 1997; Czerska, 1997; Doniecki, 2004; Grouard & Meston, 1997; Masłyk-Musiał, 1996; Masłyk-Musiał, 2003; Mikołajczyk, 2003; Zarębska, 2002), and will not be discussed here as far as the sources and the rules of eliminating it from the sociological approach are concerned. Whereas it is interesting to have a look at the source of resistance in a system approach, particularly the structure of relations inside of the object counteracting in response to an enforcing stimulus. In order to answer the question on what the resistance depends on and how it is stimulated, a functional model based on the obtained operator transmittance has to be built. The research proved that the coefficient of the polynomial of numerator T_3 is usually lower than zero and responds to the situation when the object manifests symptoms of resistance in the beginning of change implementation. The negative value of this parameter actually means a counteracting of the main trend of being decisive about the response to a stimulus. The main trend of the object manifests itself leaning towards the change, hence it is logical that the resistance has a tendency to counteract. As a block scheme the situation will be represented by the existence of a summative knot (Figure 3).

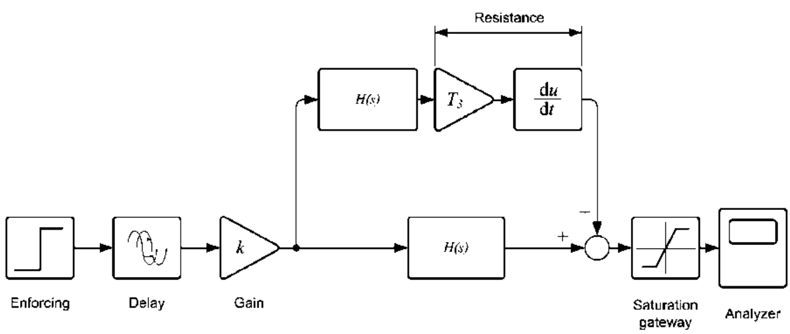

Figure 3. A Diagram of a System with a Separate Resistance Track

Source: (Wiśniewski, 2010).

The appearance of this nonzero numerator component in the polynomial proves the existence of a derivative action effect, i.e. the immediate reaction of element. The value of the reaction signal is directly proportional to the rate of the input changes. Moreover, the existence of component T_3 in the transmittance numerator indicates that the object functions on the basis of the sum of components with the common denominator:

$$G(s) = \frac{T_3 s + 1}{T_0^2 s^2 + 2\zeta T_0 s + 1} = \frac{T_3 s}{T_0^2 s^2 + 2\zeta T_0 s + 1} + \frac{1}{T_0^2 s^2 + 2\zeta T_0 s + 1} \quad (6)$$

$$G(s) = T_3 s H(s) + H(s) \quad (7)$$

The structure of a system with enumerated properties can be presented in the form of a block diagram.

In order to simplify the structure, the double appearance of the element *H(s)* should be replaced. It is also logical in relation to practical realization of the system: a given element with a specific characteristic appears there only once. The set of properties described by the transmittance *H(s)* is responsible for the system inertia. A transformed version of the diagram is presented in Figure 4.

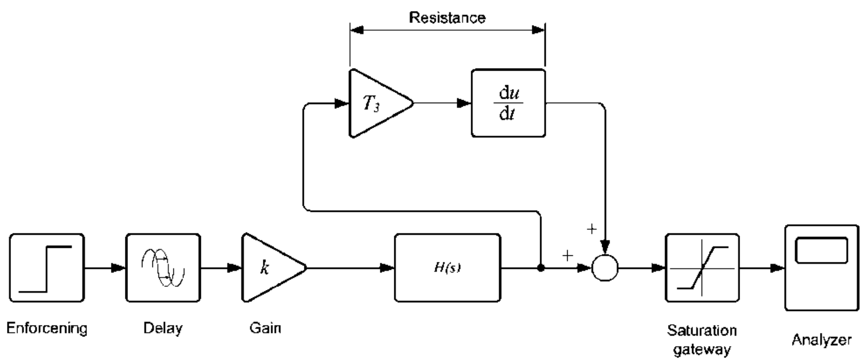

Figure 4. A Simplified Diagram of a System with a Separate Resistance track

Source: (Wiśniewski, 2010).

For this diagram, the course of the output signal in time function is presented in Figure 5. This is a characteristic generated for the delay τ_0 = *10* time units (jc), T_0 = *14.1jc*, ζ = *7.1*, T_3 = *-0.8jc*, *k* = *1*.

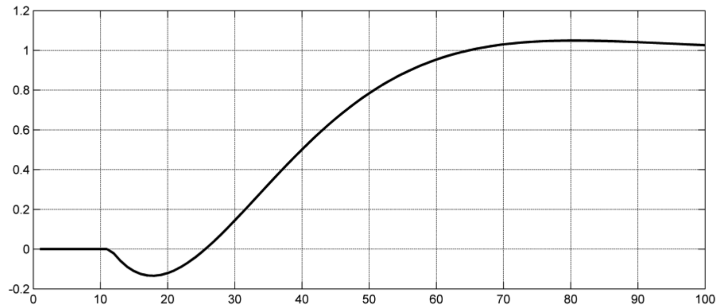

Figure 5. The Course of Response to a Stimulus with Resistance and Overload

the abscissa axis in the scale of conventional time units "jc"; the ordinate determines the effect amplitude: 1 is the targeted effect

Source: (Wiśniewski, 2010).

The notation proposed in the formula (3) can be presented in the root form, as long as the polynomial of denominator contains real roots.

$$G(s) = k\left(\frac{T_3 s + 1}{(T_1 s + 1)(T_2 s + 1)} e^{-s\tau_0}\right) \tag{8}$$

This type of recording is easy to interpret, because time constants, having direct relations to the real object, are given in an explicit way.

Establishing relations between dynamic parameters attained during identification and other parameters describing the model of changes implementation in specific conditions is subject to further analyses. The aim of the considerations is to determine possible correlations and the potential influence of some parameters characterizing the changes implementation environment and the features of the change itself on dynamic properties of an object participating in the change realization process.

DISCUSSION AND CONCLUSIONS

The research enabled the determining of the dynamic structure of an object under implementation of changes. The structure reflects the character of basic phenomena hampering the achievement of the best results in the processes of changes. Moreover, the research enabled us to find out the existence of premises for stating that human behaviour, when facing a change, proves its similarity to dynamic properties of the objects of control, such as: strengthening, counteraction, oscillation (overload), delay and inertia. People and groups have dynamic features, which can be identified via the observation of an experiment with stimulus in the form of a change. Dynamic features are not constant, they evolve, and in some rare cases they undergo abrupt changes. On the basis of identification methods, dynamic parameters of objects and the environment can be given. In the cycle of changes implementation it is worth using the known properties to determine the structure of the subsystem for improvement of change implementation effectiveness. The effectiveness of the functioning subsystem, when applying influence consciously on the organization subsystems, can be accordingly increased. For this purpose, algorithms of changes implementation control should be used based on the known effects and dynamic properties of the organization.

REFERENCES

Austin, M.J. (1997). Guiding organizational change. *New Directions for Higher Education, 98*, 31–56.
Baugier, J., & Vuillod, S. (1993). *Strategie zmian w przedsiębiorstwie. Nowoczesna metoda.* Warszawa: Poltext.
Bielińska, E. (ed.), (1997). *Identyfikacja procesów.* Gliwice: Wydawnictwo Politechniki Śląskiej.
Cameron, K.S., & Quinn, R.E. (2003). *Kultura organizacyjna–diagnoza i zmiana*, Kraków: Oficyna Ekonomiczna.
Carr, D.K., Hard, K.J., & Trahant, W.J. (1998). *Zarządzanie procesem zmian.* Warszawa: Wydawnictwo Naukowe PWN.
Clarke, L. (1997). *Zarządzanie zmianą.* Warszawa: Gebethner i S–ka.
Czerska, M. (1997). *Jak przeprowadzać zmiany organizacyjne w firmie?* Gdańsk: ODDK.
Dietrich, E., & Schulze A. (2000). *Metody statystyczne w kwalifikacjach środków pomiarowych maszyn i procesów produkcyjnych.* Warszawa: Notika System.
Doniecki, W. (2004). *Strategie zmian. Refleksje nad praktyką.* Warszawa: Wydawnictwo SWPS "Academica".
Francik, A. (2003). *Sterowanie procesami innowacyjnymi w organizacji.* Kraków: Wydawnictwo Akademii Ekonomicznej w Krakowie.
Grouard, B., & Meston, F. (1997). *Kierowanie zmianami w przedsiębiorstwie.* Warszawa: Poltext.
Halawa, J. (2007). *Symulacja i komputerowe projektowanie dynamiki układów sterowania.* Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej.
Iwasiewicz, A. (1999). *Zarządzanie jakością.* Warszawa: Wydawnictwo Naukowe PWN.
Masłyk-Musiał, E. (1996). *Zarządzanie zmianami w firmie.* Warszawa: Centrum Informacji Menedżera.
Masłyk-Musiał, E. (2002). Zarządzanie zmianami – kluczowe kompetencje w firmie. *Współczesne Zarządzanie, 1(4)*, 7–24.
Masłyk-Musiał, E. (2003). *Organizacje w ruchu: strategie zarządzania zmianami.* Kraków: Oficyna Ekonomiczna.
Mazur, M. (1966). *Cybernetyczna teoria układów samodzielnych.* Warszawa: PWN.
Mazur, M. (1976). *Cybernetyka i charakter.* Warszawa: Państwowy Instytut Wydawniczy.
Mikołajczyk, Z. (2003). *Zarządzanie procesem zmian w organizacjach.* Katowice: Górnośląska Wyższa Szkoła Handlowa.
Skoczowski, S., Osypiuk, R., & Pietrusewicz K. (2006). *Odporna regulacja PID o dwóch stopniach swobody.* Warszawa: Wydawnictwo Naukowe PWN.
Stickland, F. (1998). *The dynamics of change: insights into organisational transition from the natural world.* London and New York: Routledge.
Wiśniewski, Z. (2010). *Wdrażanie zmian w organizacji. Ujęcie dynamiczne.* Łódź: Wydawnictwo Politechniki Łódzkiej.

Wiśniewski, Z. (2006). Wdrażanie zmian – metodyka oparta na właściwościach dynamicznych organizacji. In M. Trocki (Ed.), *Nowoczesne Zarządzanie – Koncepcje i Instrumenty,* (pp. 147–153). Warszawa: Oficyna Wydawnicza Szkoły Głównej Handlowej.
Wiśniewski, Z. (2007). Modelowanie systemów produkcyjnych w oparciu o ich właściwości dynamiczne. In R. Knosala (Ed.), *Komputerowo zintegrowane zarządzanie,* (pp. 482–488). Opole: Oficyna Wydawnicza Polskiego Towarzystwa Zarządzania Produkcją.
Zarębska, A. (2002). Zmiany organizacyjne w przedsiębiorstwie. Warszawa: Difin.

MODEL DYNAMIKI OPORU W PROCESIE ZMIAN

Abstrakt

Tło badań. Artykuł przedstawia wnioski z analizy dynamiki procesu zmian. Autor proponuje zastosowanie specyficznego podejścia do realizacji procesów wdrażania zmian na poziomie operacyjnym zarządzania, nazwanego DBMCI (Dynamic–Based Model of Changes Implementation). Przyjmuje się w nim, że poszczególne składniki organizacji tworzą systemy. Systemy te, jak każde inne, podlegają pewnym prawidłowościom: generują sygnały wyjściowe w oparciu o poziomy i dynamikę sygnałów wejściowych. Najistotniejszą jednak cechą systemu jest jego charakterystyka statyczna i dynamiczna, czyli rodzaj funkcji przekształcającej wejście w wyjście. Znając charakterystykę systemu i przebieg sygnałów wejściowych można próbować określić wartość sygnałów wyjściowych. Znajomość charakterystyki danego systemu może umożliwić nie tylko przewidywanie jego zachowań, ale również umożliwić zastosowanie układu regulacji, by parametry wyjściowe zachowywały pewne ustalone z góry właściwości, bez względu na stan wejść.
Cele badań. Celem prezentowanych badań jest identyfikacja parametrów dynamicznych obiektów poddawanych zmianom.
Metodyka. Rejestracji efektów i reakcji na wymuszenia zmian dokonano dla wybranych stanowisk (jednoosobowych) oraz grup pracowników. Rejestracja polegała na obserwacji przebiegu normalnych procesów organizacyjnych w rzeczywistym środowisku społeczno–techniczno–informacyjnym.
Kluczowe wnioski. Efektem badań było stworzenie modelu podsystemu organizacji poddanego zmianom. Znajomość parametrów dynamicznych może pozwolić lepiej sterować procesami zmian i uzyskiwać ich lepszą efektywnością.

Słowa kluczowe: zarządzanie zmianą, dynamika zmian, opór przed zmianami