SYSTEMOLOGICAL BASES OF BUSINESS INTELLIGENCE

Mikhail Bondarenko, Ekaterina Solovyova, Dmitriy Elchaninov

Abstract: Sustainable development support, balanced scorecard development and business process modeling are viewed from the position of systemology. Extensional, intentional and potential properties of a system are considered as necessary to satisfy functional requirements of a meta-system. The correspondence between extensional, intentional and potential properties of a system and sustainable, unsustainable, crisis and catastrophic states of a system is determined. The inaccessibility cause of the system mission is uncovered. The correspondence between extensional, intentional and potential properties of a system and balanced scorecard perspectives is showed. The IDEF0 function modeling method is checked against balanced scorecard perspectives. The correspondence between balanced scorecard perspectives and IDEF0 notations is considered.

Keywords: business intelligence, sustainable development, balanced scorecard, business process modeling, systemology.

ACM Classification Keywords: H. Information Systems - H.1 Models and Principles - H.1.1 Systems and Information Theory - General systems theory.

Conference: The paper is selected from Sixth International Conference on Information Research and Applications – i.Tech 2008, Varna, Bulgaria, June-July 2008

Introduction

Business intelligence helps commercial enterprises to solve following important problems:

- sustainable development support;
- balanced scorecard development;
- business process modeling.

These problems are closely interrelated. Many academic researchers have advanced the ideas of the sustainable balanced scorecard in publications [Figge et al, 2001]. There are ideas of sustainable business process modeling [Pipero, 2007]. A great deal of theories and principles of sustainability are developed [Scottish Executive, 2006]. In [Bossel, 1999] systems theory is used to identify the vital aspects of sustainable development.

In this paper sustainable development support, balanced scorecard development and business process modeling are viewed from the position of systemology [Melnikov, 1988]. From a point of systemological view a system must satisfy functional requirements of a meta-system (see fig. 1). A system must have corresponding extensional properties to satisfy functional requirements of a meta-system. Intentional properties of a system may be transformed to extensional properties as well as potential properties towards intentional properties.

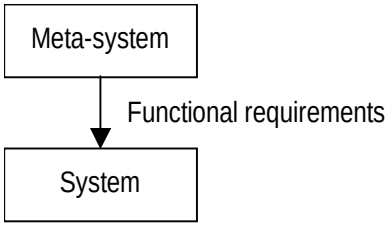

Figure 1: Functional requirements for a system

Systemological Bases of Sustainable Development

A current state of a system is sustainable if extensional properties of the system satisfy functional requirements of a meta-system.

Example 1. Consider a system S. Let:

- Ext={X_1, X_2, X_3} be a set of extensional properties of S;
- Int={X_4, X_5, X_6} be a set of intentional properties of S;
- Pot={X_7, X_8, X_9} be a set of extensional properties of S;
- St=Ext∪Int∪Pot be a current state of S.

By F denote a set of functional requirements of a meta-system. If F⊂Ext then St is sustainable (see fig. 2, where F={X_1, X_2, X_3}).

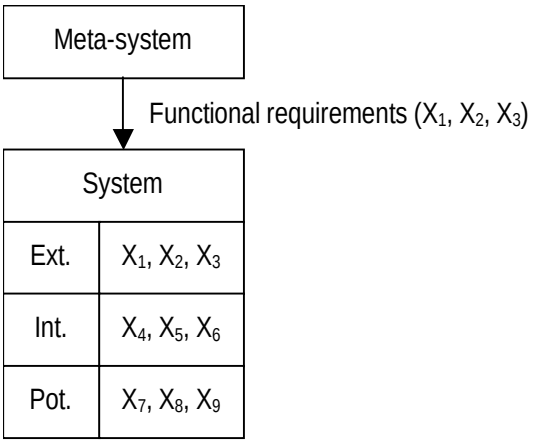

Figure 2: The current sustainable state of the system

If F is transformed from {X_1, X_2, X_3} to {X_4, X_5, X_6} then S may adapt to new F by transforming {X_4, X_5, X_6} from Int to Ext in the following way (see fig. 3):

- Ext:=(Ext\{X_1})∪{X_4}={X_4, X_2, X_3} and Int:=(Int\{X_4})∪{X_1}={X_1, X_5, X_6};
- Ext:=(Ext\{X_2})∪{X_5}={X_4, X_5, X_3} and Int:=(Int\{X_5})∪{X_2}={X_1, X_2, X_6};
- Ext:=(Ext\{X_3})∪{X_6}={X_4, X_5, X_6} and Int:=(Int\{X_6})∪{X_3}={X_1, X_2, X_3}.

Now again F⊂Ext and new St is sustainable.

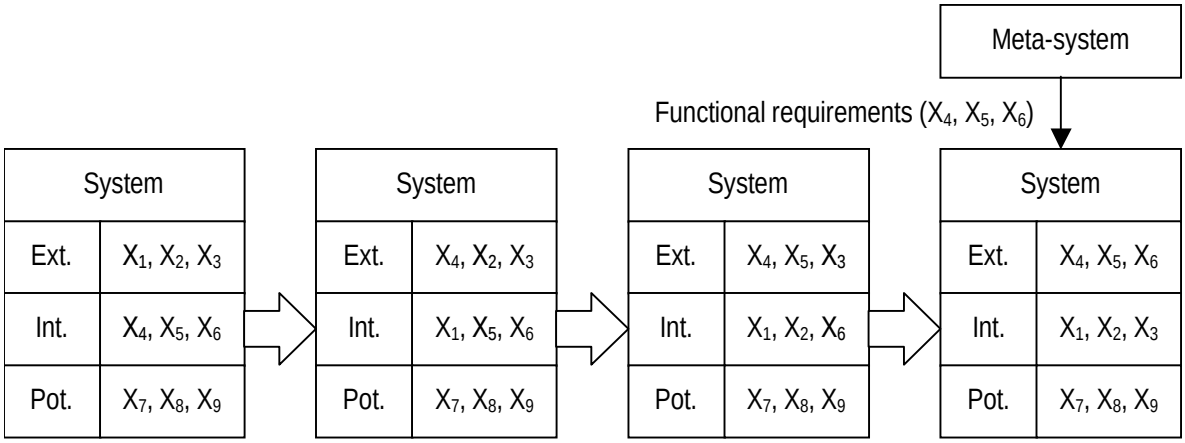

Figure 3: The adaptation of the system

If F is transformed from $\{X_1, X_2, X_3\}$ to $\{X_7, X_8, X_9\}$ then S may evolve towards new F by transforming $\{X_7, X_8, X_9\}$ from Pot to Ext in the following way (see fig. 4):

- $Ext:=(Ext\setminus\{X_3\})\cup\{X_6\}=\{X_1, X_2, X_6\}$ and $Int:=(Int\setminus\{X_6\})\cup\{X_3\}=\{X_4, X_5, X_3\}$;
- $Int:=(Int\setminus\{X_4, X_5\})\cup\{X_7, X_8\}=\{X_7, X_8, X_3\}$ and $Pot:=(Pot\setminus\{X_7, X_8\})\cup\{X_4, X_5\}=\{X_4, X_5, X_9\}$;
- $Ext:=(Ext\setminus\{X_1, X_2\})\cup\{X_7, X_8\}=\{X_7, X_8, X_6\}$ and $Int:=(Int\setminus\{X_7, X_8\})\cup\{X_1, X_2\}=\{X_1, X_2, X_3\}$;
- $Int:=(Int\setminus\{X_3\})\cup\{X_9\}=\{X_1, X_2, X_9\}$ and $Pot:=(Pot\setminus\{X_9\})\cup\{X_3\}=\{X_4, X_5, X_3\}$;
- $Ext:=(Ext\setminus\{X_6\})\cup\{X_9\}=\{X_7, X_8, X_9\}$ and $Int:=(Int\setminus\{X_9\})\cup\{X_6\}=\{X_1, X_2, X_6\}$;
- $Int:=(Int\setminus\{X_1\})\cup\{X_4\}=\{X_4, X_2, X_6\}$ and $Pot:=(Pot\setminus\{X_4\})\cup\{X_1\}=\{X_1, X_5, X_3\}$.

Now again $F\subset Ext$ and new St is sustainable.

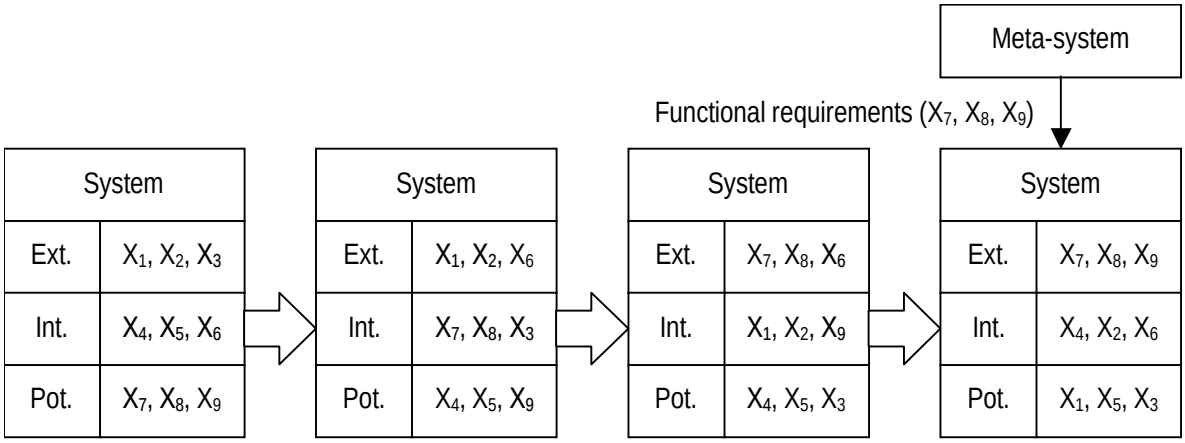

Figure 4: The evolution of the system

Let F be transformed in the following way $F_1 \rightarrow F_2 \rightarrow F_3$. If $F_1\subset Ext$ and $F_2\subset Int$ and $F_3\subset Pot$ then St is strong sustainable. S may both adapt and evolve towards new F. If $F_1\subset Ext$ and $F_2\subset Int$ and $F_3\not\subset Pot$ then St is weak sustainable. S may adapt to F_2 only.

Let F be transformed in the following way $F_1 \rightarrow F_2$. If $F_1\subset Ext$ and $F_2\not\subset Int$ and $F_2\subset Pot$ then St is weak unsustainable. S may evolve towards F_2. If $F_1\subset Ext$ and $F_2\not\subset Int$ and $F_2\not\subset Pot$ then St is strong unsustainable. Any adaptation or evolution is impossible.

If $F=F_1$ and $F_1\not\subset Ext$ and $F_1\subset Int$ then St is crisis. Let F be transformed in the following way $F_1 \rightarrow F_2$. If $F_2\subset Pot$ then St is weak crisis. S may both adapt and evolve towards new F. If $F_2\not\subset Pot$ then St is strong crisis. S may adapt to F_1 only.

If $F=F_1$ and $F_1\not\subset Ext$ and $F_1\not\subset Int$ and $F_1\subset Pot$ then St is weak catastrophic. S may evolve towards F_1. If $F=F_1$ and $F_1\not\subset Ext$ and $F_1\not\subset Int$ and $F_1\not\subset Pot$ then St is strong catastrophic. Any adaptation or evolution is impossible.

The results are showed in table 1, where symbol “1” denotes the presence of corresponding properties, “0” – the absence.

Table 1: The correspondence between properties and states of a system

Properties	States							
	sustainable		unsustainable		crisis		catastrophic	
extensional	1	1	1	1	0	0	0	0
intentional	1	1	0	0	1	1	0	0
potential	1	0	1	0	1	0	1	0

Systemological Bases of Balanced Scorecard

"Mission" is a key concept of balanced scorecard (BSC) [Kaplan and Norton, 1999], [Kaplan and Norton, 2001]. The mission statement describes the organization's statement of purpose; what it is doing and why. The mission is never accomplished by any organization [Niven, 2002]. Let's uncover the inaccessibility cause of the system mission.

From a point of systemological view, system mission is meta-system functional requirements.

Consider a system S, a meta-system MS and a meta-meta-system MMS. By X denote a set of functional requirements of MS. By Y denote a set of functional requirements of MMS. X varies depending on Y. Let $X=X_1$ corresponds to $Y=Y_1$. Finally, let S adapts to $X=X_1$.

If $Y=Y_1$ transforms to $Y=Y_2$ then $X=X_1$ transforms to corresponding $X=X_2$. Therefore, now S must adapt to new $X=X_2$ and so on (see fig. 5).

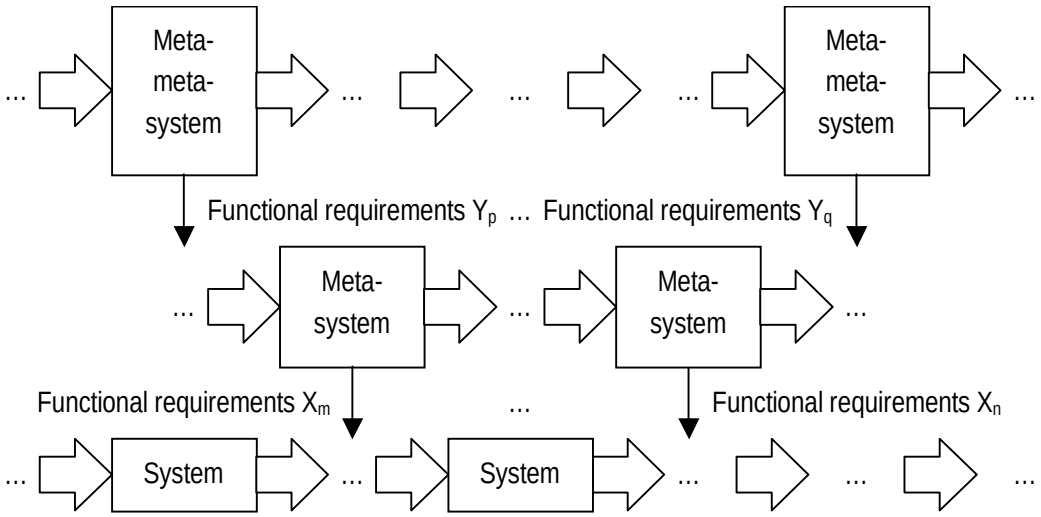

Figure 5: Inaccessible mission of a system

BSC suggests a new performance measurement approach that focuses on corporate strategy in four perspectives.

The financial perspective effects relationships referring to the other BSC perspectives.

The customer perspective represents the customer value proposition through which the business system wants achieve a competitive advantage. Therefore, the customer perspective corresponds to extensional properties of the business system.

The internal process perspective identifies those internal business processes, which enable the business system to meet the expectations of customers. Hence, the internal process perspective corresponds to intentional properties of the business system.

In the learning and growth perspective, the most important area is qualification of employees. And so, the learning and growth perspective corresponds to potential properties of the business system.

Table 2: The correspondence between properties of a system and BSC perspectives

Properties	Perspectives
extensional	customer
intentional	internal process
potential	learning and growth

Balanced Scorecard Bases of Business Modeling

Business process modeling is a critical component of business intelligence because a business strategy is implemented by business processes. IDEF0 activity modeling is a technique for analyzing whole systems as a set of interrelated activities or functions [Methods Guide, 2002]. Let's check the IDEF0 function modeling method against balanced scorecard perspectives.

Outputs are the material or information produced by the activity. Therefore, output arrows correspond to the customer perspective (see fig. 6).

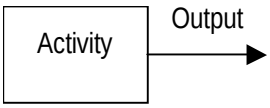

Figure 6: Customer perspective modeling

An activity can be decomposed into its constituent activities. Inputs represent material or information that is consumed or transformed by the activity in order to produce the outputs. Controls govern or regulate how, when, and if an activity is performed and which outputs are produced. Hence, activities, input and control arrows correspond to the internal process perspective (see fig. 7).

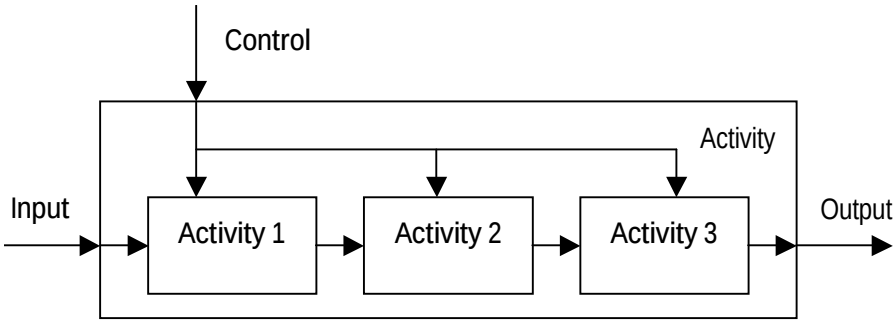

Figure 7: Internal process perspective modeling

Mechanisms are those resources that perform the activity. And so, mechanism arrows correspond to the learning and growth perspective (see fig. 8).

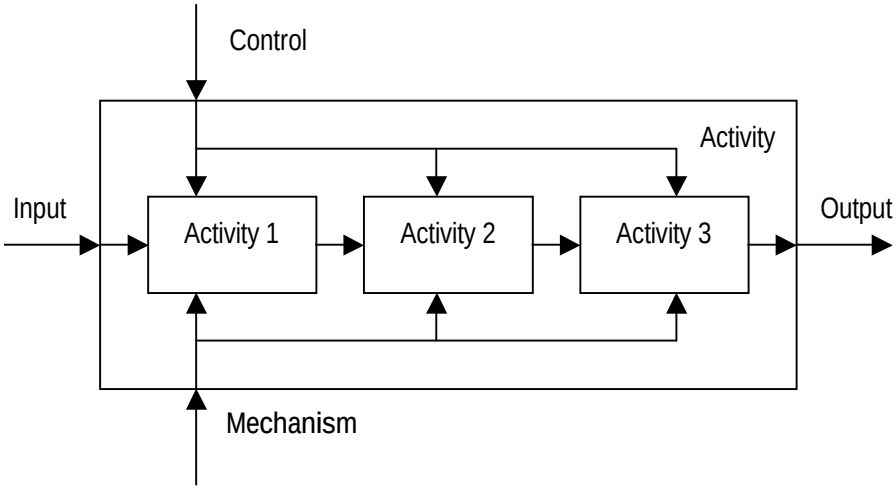

Figure 8: Learning and growth perspective modeling

The correspondence between BSC perspectives and IDEF0 notations is presented in table 3. Using the correspondence between properties of a system and BSC perspectives, one can make the correspondence between properties of a system and IDEF0 notations.

Table 3: The correspondence between BSC perspectives and IDEF0 notations

Perspectives	Notations
customer	output arrow
internal process	activity, input and control arrow
learning and growth	mechanism arrow

Conclusion

Systemology is unified theoretical basis for different aspects of business intelligence: sustainable development support, balanced scorecard development and business process modeling (see resulting table 4).

Table 4: The correspondence between properties, states, perspectives and notations

Notations	Perspectives	Properties	States							
			sustainable		unsustainable		crisis		catastrophic	
output arrow	customer	extensional	1	1	1	1	0	0	0	0
activity, input and control arrow	internal process	intentional	1	1	0	0	1	1	0	0
mechanism arrow	learning and growth	potential	1	0	1	0	1	0	1	0

Bibliography

[Bossel, 1999] Bossel H. Indicators for Sustainable Development: Theory, Method, Applications. A Report to the Balaton Group. International Institute for Sustainable Development: Winnipeg, Canada, 1999.

[Figge et al, 2001] Figge F., Hahn T., Schaltegger S., Wagner M. The Sustainability Balanced Scorecard – Translating Strategy into Value-Based Sustainability Management. Conference Proceedings of Business Strategy and the Environment 2001 in Leeds, UK. ERP Environment, 93-102.

[Kaplan and Norton, 1999] Kaplan R., Norton D. The Balanced Scorecard: Translating Strategy into Action. Boston, 1999.

[Kaplan and Norton, 2001] Kaplan R., Norton D. The Strategy Focused Organization. Boston, 2001.

[Melnikov, 1988] Melnikov G.P. Systemology and Linguistic Aspects of Cybernetics. New York, Paris, Monterey, Tokyo, Melbourne: Gordon and Breach. 1988.

[Methods Guide, 2002] AllFusion Process Modeler. Methods Guide 4.1. Computer Associates International, Inc., 2002.

[Niven, 2002] Niven P. Balanced Scorecard Step-by-Step: Maximizing Performance and Maintaining Results. John Wiley & Sons, Inc., New York, 2002.

[Pipero, 2007] Pipero C. Sustainable Business Process Management with BPMN, XAML and B2MML. WBF, North American Conference, Baltimore, MD, USA. 30 April - 3 May 2007.

[Scottish Executive, 2006] Sustainable Development: A Review of International Literature. Edinburgh: Scottish Executive, 2006. http://www.scotland.gov.uk/Publications/2006/05/23091323/17

Authors' Information

Mikhail Bondarenko – Rector, Kharkov National University of Radio Electronics, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: rector@kture.kharkov.ua

Ekaterina Solovyova – Head, Social Informatics Department, Kharkov National University of Radio Electronics, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: si@kture.kharkov.ua

Dmitriy Elchaninov – Assistant Professor, Social Informatics Department, Kharkov National University of Radio Electronics, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: elchaninov@kture.kharkov.ua