

## **BUSINESS PROCESS SIMULATION ROOTS IN INFORMATION PROCESSING VIEW OF ORGANIZATIONS**

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**Abstract:** This study aims to highlight the relations between Business Process Simulation (BPS) and organizational theory, in particular the view of organizations as information processors. Although BPS emerged as a practice-oriented set of techniques without strong linkages to organizational theories, contingency theory concepts are clearly embedded into BPS approach. For that reason, it is possible to state that BPS approach inherits the strong constructs of the information processing view of organizations. In addition to that, classical simulation steps can be clearly identified as part of the structure of a BPS implementation. In order to show the differences among the application of BPS and of the most widespread simulation techniques (e.g. System Dynamics, agent based approaches), a comparison table is developed. This study advocates for a deeper understanding of the potentialities of BPS and its impact on organizational design.

### **INTRODUCTION**

During the Nineties Business Process Reengineering (BPR) (Hammer & Champy, 1993) emerged as one of the most effective techniques to drive organizational change, experiencing an incredible fortune in management and consulting practices. Information and Communication Technologies development has allowed the advance of simulation techniques that can be used in BPR projects and, more broadly, in all organizational innovation projects. Business Process Simulation (BPS) is one of the techniques originated by such development. Academic literature about BPS is not particularly developed, compared to the rise of managerial approaches to business process modeling and simulation. However, since major players in information systems – such as SAP, IBM and Oracle – have included BPS tools in their products, this argues in favor of the important role that these techniques may assume within organizational change projects. Given that, it deserves particular interest to investigate the theoretical roots of BPS in organizational theory.

### **BPS THEORETICAL ROOTS**

This work identifies the conceptual predecessor of BPS in the paradigm that sees organizations as information processors (Galbraith, 1973; Pugh, et al., 1963; Simon, 1973). Information processing models (Daft & Lengel, 1986; Galbraith, 1974; Tushman & Nadler, 1978) are strongly inspired by contingency theory (Lawrence & Lorsch, 1967; Perrow, 1967) and draw attention on information as the main contingency (Galbraith, 1974). In this view, organization design should focus on seeking the appropriate level of fitness with the information contingency. The fit concept is developed with a particular attention on the information contingency (Premkumar, Ramamurthy, & Saunders, 2003). Seminal works from the information processing view of organizations claim for an active role of organizational designers. The foresights about the use of simulation techniques in organizational design are justified by the need to predict possible performance outcomes (Galbraith, 1974; Simon, 1973). Organizations need flows of information to cope with environmental uncertainty and perform their decision making process. Environmental uncertainty stems from the complexity and dynamism of the environment or from the frequency of change of various environmental variables (Duncan, 1972). Galbraith (1973) identifies three important concepts – information processing needs, information processing capability, and the fit between the two – that have to be considered for a performance improvement. Studies on organizational structure are frequent in management literature, while the lack of a rich theoretical background on processes analysis is remarkable. The focus on processes claims for a study of their dynamic nature, their mapping and their interconnection with structure (Furey, 1993; Kettinger, Teng, & Guha, 1997). Simulation is useful in process design because it supports the understanding of the performance level reachable by different processes configurations. In this idea processes represent an intermediate layer between organizational dimensions and performance combinations. They are defined as “the direction and frequency of work and information flows linking the differentiated roles within and between departments of the complex organization” (Galbraith & Nathanson, 1978). A process in simulation terminology is defined as a time-ordered sequence of interrelated events – activities – which describes the entire experience of an entity as it flows through a system (Law & Kelton, 1991). This definition is closely related to the one formulated by Galbraith &

Nathanson (1978).

### BPS ADVANTAGES

In this paragraph we consider typical BPS advantages, while for a review about research contributions of simulation techniques see Davis et al. (2007) and Harrison et al. (2007).

In the context of process design the application of a simulation can help to understand the possible future configurations of performance indicators. BPS can be used as a predictive technique to analyze the link between organizational variables and performances (Greasley, 2003). Typical performance measures regard time, costs, cycle time and resource utilization (Vergidis, Tiwari, & Majeed, 2008). The simulation output appears particularly powerful in prescriptive organizational approaches, such as the view of organization as information processors, which have to deal with future outcomes of organizational change activities.

A second argument that supports the application of simulation to organization design is related to complexity: in the early Sixties, Simon and Clarkson (1960) argue that simulation “allows a degree of complexity to be handled that would be unthinkable if inferences could be drawn from the model only by standard analytical techniques”. Galbraith (1977) identifies a set of five organizational dimensions that are the levers of change involved in change projects. The main idea behind his model is that the levers are interconnected with complex relations, so it is not reasonable to approach such complexity of relations applying operational research techniques. Typical operational research approaches requires, in fact, the definition of relatively simple model functions in order to obtain the optimal solution.

The third group of advantages regards the possibility to conduct experiments. BPS enables the analysis of different process configurations in order to allow managers to acquire a deeper understanding of the consequences of their decisions. To summarize, BPS allows to deal with variability and interdependence, (Greasley, 2003). Variability regards the stochastic form that input variables assume in the system. In particular, BPS offers the possibility to analyze performance outcomes as statistical distributions resulting from system’s processing of stochastic inputs. Interdependence deals with the complexity of interrelation between organizational variables. In this case, BPS is not focused in finding the optimal configuration of interdependences, but in providing performance values related to each experiment (Vergidis, et al., 2008).

### SIMULATION METHODOLOGIES COMPARISON

In this paragraph, the main simulation approaches to support organization design are reviewed, comparing them with BPS and presenting their characteristics and typical application field. This comparison considers what emerged from recent reviews (Davis, et al., 2007; Harrison, et al., 2007; Jahangirian, et al., 2010) that identify the three most widespread and acknowledged approaches – Discrete Event Simulation (DES), System Dynamics and agent based approaches. For a definition of agent based simulation and related works see Harrison et al. (2007). BPS can be considered belonging to DES techniques, which are mainly used in operation research studies. The intent of the following comparison is to point out the role of BPS in organization design projects. The differences among simulation approaches are outlined in Table 1.

	<b>System Dynamics</b> (Davis, et al., 2007)	<b>Agent based approaches</b> (Davis, et al., 2007; Harrison, et al., 2007)	<b>BPS</b>
<b>Focus</b>	Behavior of a system with complex causality and timing.	Behaviors of adaptive actors who make up a social system and who influence one another through their interactions.	Performance analysis of a complex activity networks routed by entities.
<b>Description</b>	Diagrams of variables connected with arrows (including feedback loops) that show the directions of influence of variables on one another	Simulation of the behavior of the agents including their acts to influence one another. The outcomes of interest typically are the consequences of the agent behaviors for the social system as a whole.	Statistical distributions characterize the arrival of entities into the system and their flow within the activities network.
<b>Common research</b>	Conditions (tipping points, catastrophes,	Consequences of the agent behaviors for the social	• Levels of performance reachable by different processes configurations;

<b>questions</b>	and emergence of vicious or virtuous cycles) that generate system instability (abrupt, nonlinear changes).	system as a whole, for example the speed and the effectiveness of adaptation to an optimum, within a modular system influenced by interaction between system components.	<ul style="list-style-type: none"> <li>• Analysis of interactions between actors that take part to the same process;</li> <li>• Identification of inefficiencies and vicious loops in processes;</li> <li>• Possible performances improvements reachable by the introduction of information technology solutions.</li> </ul>
<b>Common experiments</b>	<ul style="list-style-type: none"> <li>• Add causal loops;</li> <li>• Change parameters in flow rates.</li> </ul>	<ul style="list-style-type: none"> <li>• Change the relations among agents;</li> <li>• Apply different environmental conditions.</li> </ul>	<ul style="list-style-type: none"> <li>• Apply different input conditions to the system by changing the distributions of input variables;</li> <li>• Test the system under stress conditions;</li> <li>• Vary the availability of resources.</li> </ul>
<b>Examples</b>	Modeling organizational change as a function of other variables, (Sastry, 1997).	Modeling individual interactions in an organization, (Levinthal, 1997) or organizations interactions in an industry (March, 1991).	<ul style="list-style-type: none"> <li>• Simulation of workflow activities, e.g. manufacturing or back office procedures (Greasley, 2003; Hlupic &amp; Robinson, 1998);</li> <li>• Simulation of operations supported by ICT tools (Greasley, 2003).</li> </ul>

**Table 1** Comparison between System Dynamics, Agent based approaches and BPS

Each simulation approach may be supported by IT based tools to model and run the simulation, usually such instruments are stand alone applications not integrated within the organization's management information systems. In the case of BPS, specific software has been developed to interface enterprises' information systems allowing to collect input data, to perform simulations and also to customize information systems during the redesign stage. Major players in information systems – such as SAP, IBM and Oracle – offer complete suites to design and run simulations. Open source applications are also available even if usually they are less complete in terms of simulation function support. The specific characteristics of BPS and the availability of the above mentioned software applications may help the diffusion of such simulation methodology in supporting organization change projects and BPR ones in particular.

### BPS STEPS

Implementing a simulation requires to adopt a clearly defined procedure. In this paragraph, a BPS application methodology is discussed presenting its typical steps. Due to the lack of a common accepted methodology, Giaglis' ISEC methodology (1999) is chosen because of its completeness. ISEC (Initiate, Simulate, Experiment, Conclude) methodology is an attempt to define clear steps to address BPS in the context of a BPR project. ISEC methodology is compared in Table 2 to traditional simulation approaches (Davis, et al., 2007), from one side, and to BPR steps, on the other side (Furey, 1993; Kettinger, et al., 1997), in order to show their common background.

<b>ISEC methodology for BPS</b> (Giaglis, Paul, & Hlupic, 1999)	<b>General simulation approach steps</b> (Davis, et al., 2007)	<b>BPR approach</b> (Furey, 1993; Kettinger, et al., 1997)
<b>Initiate:</b> define scope and objectives, define the desired levels of performance.	Create the computational representation.	Envision and Initiate: establish management commitment and identify the customer driven process objectives.
<b>Simulate:</b> develop the simulation AS-IS model and verify it.	Verify the computational representation.	Diagnose: map and measure the existing process (AS-IS).
<b>Experiment:</b> design TO-BE models and run their simulations.	Experiment to build novel theory.	Redesign: analyze the existing process, benchmark for proven existing alternatives and reengineer the process (TO-BE).
<b>Conclude:</b> decide on proposed changes.	Validate with empirical data.	Reconstruct and evaluate: roll out the new process and measure performances.

**Table 2** Comparison between BPS, BPR and general simulation steps

ISEC methodology is made of four steps and resembles a typical BPS schema. It matches the phases of a typical BPR project with the support of computational techniques. The main distinction with BPR comes from the fact that BPR lacks of a systematic approach for performance evaluation. This is not only due to the missing reference about the use of particular tools in the initial BPR formulations (Hammer, 1990; Hammer & Champy, 1993). More likely it is due to the fact that BPR claims for a radical change in the organizational structure, so a simulation would lack the support of a validation phase on current performance indicators, as prescribed in general simulation design guidelines (Harrison, et al., 2007). Fathee et al. (1998) observe that simulation is more useful in context where business process are stable, therefore the applicability of BPS analyses to radical organizational changes need still to be fully tested.

Aguilar et al. (1999) sustain that BPS can offer a support in BPR projects, especially in specific phases such as (1) the construction and communication of AS-IS process map, (2) the measurement of processes performances, (3) the development of future process designs and (4) their implementation. Major support is offered in second and third step, while an additional role is held in first and fourth step (Greasley, 2003). BPS can be categorized in the large group of DES techniques (Greasley, 2003), but its step by step methodology reflects its closeness to BPR literature. Moreover, the fact that BPS offers a methodology to deal with variability and interdependence of organizational dimensions qualify its root in information processing view of organizations.

### CONTRIBUTIONS

While BPS developments are becoming appealing for organizations involved in processes innovation and change projects, scholars seem to be less interested in the development of a strong theoretical framework that may help in understanding and supporting the overcoming diffusion of BPS. This study is a contribution to fill such a gap between practice and theory.

Davenport's observations (1994) about the roots of BPR in previous theoretical approaches are developed for BPS, identifying a reference theoretical framework for BPS. Following Davenport & Stoddard (1994) ideas, this study argues that BPR approaches inherit the strong constructs of the information processing view of organizations and are rooted in the contingency theory perspective. It follows that organizational internal configuration should reflect the information processing requirements and the various organizational dimensions that are involved in organizational innovation and change projects. Unfortunately, standard analytical techniques – for instance the typical instruments from econometrics or from operational research – result less useful to evaluate organizational alternatives, because they cannot deal with the complexity and dynamism of relationships among organizational dimensions and performance. Simulation seems to be the most helpful method to address such a complexity, associated with the request of performing forecasts. In a business context system dynamics or agent simulations seems more difficult to apply and less acknowledged by managers.

BPS supports analysts and managers in structuring and simulate different information flows considering the complexity of relationships among organizational dimensions. Although BPS emerges as a practical technique without strong linkages to organizational theories, this study remarks that contingency theory constructs are clearly embedded into BPS approach, as classical simulation steps are clearly part of the structure of a BPS implementation.

Finally, this study advocates for a deeper understanding of the potentialities of BPS and its impact on organizational design activities. It also suggests a theoretical background as a reference to develop a better awareness of organizational decisions. The linkages between theoretical and practical constructs can support managers and consultants in considering the organizational complexity behind modeling choices in a BPS project.

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