

ACTOR-SYSTEM-DYNAMICS THEORY

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Keywords: actors, natural systems, social systems, rules, rule system, institution, collective self, interaction, consciousness, bounded knowledge, complexity, socio-cultural evolution.

Contents

1. Background and Foundations

1.1 Background and Overview

1.1.1 Actors and Social Interaction

1.1.2 Major Mechanisms of Social Stability and Transformation

1.1.3 Institutional and Cultural Structures

1.1.4 Material and Ecological Conditions

1.1.5 Rule Governed Social Interactions Produce Concrete Outcomes and Developments

1.2 Social Rule System Theory: Institutions and Cultural Formations

1.2.1 The Universality of Social Rule Systems and Rule Processes

1.2.2 Adherence to Social Rules and Rule Systems

1.2.3 Institutions and Complex Institutional Arrangements

1.3 The Theory of Consciousness and Collective Representations

1.4 Socio-Cultural Evolutionary Theory

2. Applications and Policy Implications: The Knowledge Problematique vis-à-vis Complex Systems

2.1 Introduction

2.2 Information and Accounting Systems

2.3 Bounded Knowledge and the Limits of Control of Complex Systems

Acknowledgements

Glossary

Bibliography

Biographical Sketches

Summary

This article provides an introduction and overview of the theory of actor-system-dynamics (ASD). The theory identifies a minimum set of concepts essential to dynamic

description and model-building in social system analysis. The theory has made a number of contributions to systems thinking, at least with respect to the social sciences: (1) the conceptualization of human agents as creative (also destructive), self-reflective, and self-transforming beings; (2) cultural and institutional formations as constituting the major environment of human behavior, but an environment in part internalized in the form of shared rules and rule systems; (3) interaction processes and games as embedded in cultural and institutional frameworks; (4) social systems as configurations of tension and dissonance, the clash of moral worlds, of conflicting interests and struggles among groups, of contradictory relationships, and institutional arrangements; and (5) the development and evolution of social rule systems and socio-technical systems as a function of (a) human agency manifested in interactions and games and (b) selective mechanisms which are, in part, a function of physical and ecological environments and, in part, generated by social agents in shaping and maintaining institutions and cultural formations. The human capacity for complex problem-solving and innovation provides a mechanism for generating change in technologies as well as in social institutions. ASD stresses the capacity of human agents to construct within certain constraints systems such as institutions and technologies without necessarily fully understanding how these systems will perform and evolve.

1. Background and Foundations

1.1 Background and Overview

Actor-system-dynamics (abbreviated as ASD henceforth) emerged in the 1970s out of the early systems research (see *General Systems Theory*) of Tom Baumgartner, Walter Buckley, Tom R. Burns, Philippe DeVille, and David Meeker, when all were working at the University of New Hampshire. Social relations, groups, organizations, and societies were seen as sets of inter-related parts that have more or less stable boundaries and with internal structures and processes. A key premise was that social systems are open to, and interact with, their environment. Through interaction with their environment—and through internal processes—such systems acquire new properties, and transform themselves, resulting in continual evolution.

The common assumption espoused by some system theorists, that the same concepts and principles of organization underlie the different disciplines (physics, biology, technology, sociology, and economics), was rejected from the outset. It was axiomatic that human agents should not be conceptualized as equivalent to particles, cells, electronic components, or purely physical systems. There were good empirical reasons for this, but also moral reasons. Human beings are creative as well as moral agents. They have intentionality, and they are self-reflective and consciously self-organizing beings. They may choose to deviate, oppose, or act in perverse ways.

These innovations were particularly important in light of the fact that system theories in the social sciences, particularly in sociology, were heavily criticized for the excessive abstractness of their theoretical formulations, for their failure to recognize or adequately conceptualize conflict in social life, and for persistent tendencies to overlook the non-optimal, even destructive, characteristics of some social systems. Also, many system theorists were taken to task for failing to recognize human agency, the fact that human

individuals and collectives are purposive beings, have intentions, make choices, demonstrate self-reflectivity, and participate in constructing and destroying systems. Social actors are major sources of social regularities and the forces that structure and restructure social rule systems. The individual, the historic personality as exemplified by Joseph Schumpeter's entrepreneur or by Max Weber's charismatic leader, enjoys an extensive freedom to act within and upon social systems, and in this sense enjoys a certain autonomy from them. Social rule systems are the conditions for, as well as the products of, social interaction, as indicated in Figure 1.

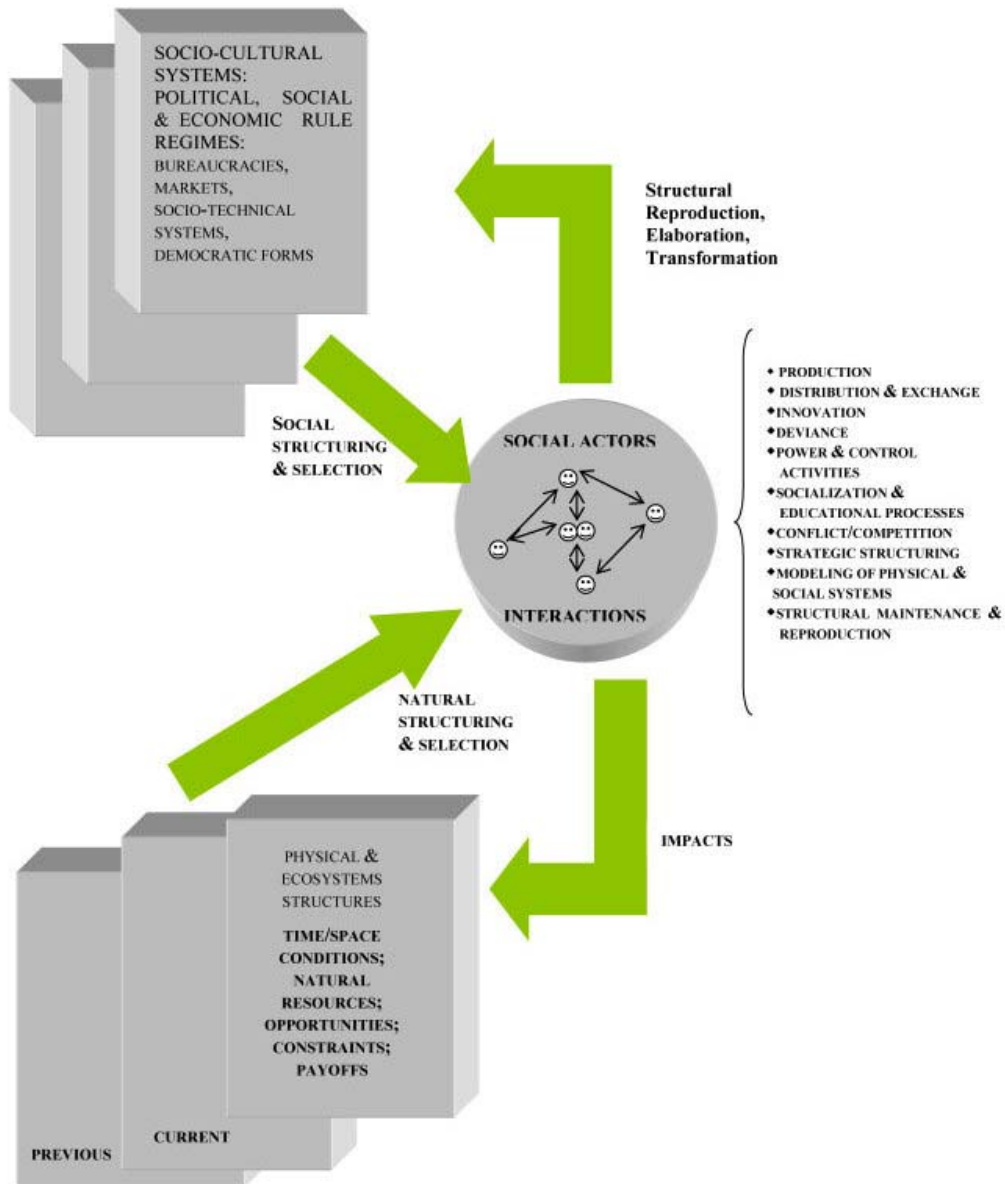


Figure 1. Model of Physical and Social System Interactions

Social systems and their processes are conceptualized and analyzed in ASD in terms distinct from natural systems. Investigation and modeling of the interactions between socio-cultural systems and natural systems provides a point of departure for the analysis

of socio-technical systems, large scale technologies, and the complex interplay between societies and their natural environment. A major implication of “bringing human agents into the picture” has been the stress on the fact that human agents are social and cultural beings. As such, human agents and their relationships are constituted and constrained by social rules and rule complexes. These are the basis on which they organize and regulate their interactions, interpret and predict interactions, and develop and articulate accounts of their affairs and conduct critical discourses.

ASD systematically links actor or agent conceptualizations to social systems, making use of and developing key mediating concepts, such as social rule, institution, and cultural formation. Social agents—through their interactions and games (organized interactions with particular “rules of the game”)—elaborate and reform such structures. In general, while human agents—individuals as well as organized groups, organizations and nations—are subject to material, political, and cultural constraints on their actions, they are at the same time active, often radically creative, forces, shaping and reshaping cultural formations and institutions as well as their material circumstances. In the process of strategic structuring, agents interact, struggle, form alliances, exercise power, negotiate, and cooperate within the constraints and opportunities of existing structures. They change, intentionally and unintentionally (often through mistakes and performance failures), the conditions of their own activities and transactions, namely the physical and social systems structuring and regulating their interactions. The results are institutional and material changes but not always as the human agents have decided or intended. This general principle is a point of departure for ASD. Figure 1 identifies a minimum set of concepts essential to dynamic description and model-building in social system analysis: (1) social agents, occupying positions and playing different roles; (2) social action and interaction (or game) settings and processes; (3) institutional and cultural formations which structure and regulate social interaction (for instance, the type of game with particular game rules); and (4) material and ecological structures, which set constraints on, as well as provide opportunities for, human initiative and interaction.

1.1.1 Actors and Social Interaction

Actors are the carriers of social rule systems and of practical knowledge essential to their implementation. At the same time, they give new and sometimes unexpected interpretations to social rules and action settings. More generally, they exhibit the capacity to innovate, demonstrating this through, for instance, reconstituting social norms and institutions as well as creating new technologies and techniques. In this way, human agents through their actions transform the very conditions of their action.

Collective actors—such as organized groups, clans, enterprises, government agencies, parliamentary bodies, political parties, and religious associations—make decisions, mobilize and allocate resources, and carry out collective actions. Such collective agents have internal structures to organize the formulation and enforcement of internal rules, the making of various types of decisions, and the execution of purposeful collective action. Such internal structures are constituted and regulated by social rule systems.

The concrete social activities of actors include such diverse activities as loving and sharing, producing, cooperating, exercising power, struggling, and warring with one

another (see Figure 1). These activities take place in concrete interaction situations in which the actors involved have unequal resources and opportunities to realize their purposes and interests. The distribution of action and interaction possibilities (including resource control) among actors determines their relative power in an ongoing interaction situation and their capability to influence future developments. Through their actions and interactions (or games, that is organized interactions with particular “rules”), social actors regulate and change their material, institutional, and cultural worlds. They are constrained, however, in doing so. Key types of constraints on agency are: (1) the particular (and limited) knowledge, skills, motivations, self-conception, and self-confidence of the actors involved; (2) institutional and cultural constraints as well as opportunities in the form of social rule systems, which constitute and regulate actors and their interaction; (3) environmental constraints on social agents and their interactions, including geographic and physical as well as technological constraints and possibilities. These constraints are specified below and in following sections.

1.1.2 Major Mechanisms of Social Stability and Transformation

Culture and institutions as well as physical structures shape and regulate interaction processes and conditions, such as those of production, exchange, conflict, the exercise of power, innovation and knowledge production, and social reproduction, at the same time that human action and interaction change these structures, as indicated in Figure 1. The following sub-sections discuss these structuring and selection mechanisms.

1.1.3 Institutional and Cultural Structures

Institutions are authoritative rule systems, exemplified by, for instance, administrative organization or bureaucracy, markets, political systems, and religious communities, which structure and regulate social interactions in particular social areas or domains. Cultural formations include language as well as other symbol systems such as, for example, money. Institutions and cultural formations are not reducible to the thoughts and acts of individuals. Much of the social order and stability we observe around us depends on institutional arrangements and a network of social controls. Such social structuring is discussed in more detail in Section 1.2.

1.1.4 Material and Ecological Conditions

Physical conditions, climate, and the distribution of natural resources such as energy, water, and arable land, as well as technologies (which are human constructions) constrain as well as provide opportunities for certain social actions and interactions.

In ASD theory, technology is defined as a set of physical artifacts and the rules employed by social actors to use those artifacts. Thus technology has both a material and a cultural aspect. The rules considered to be part of the technology are the “instruction set” for the technology, the rules that guide its operation. This term emphasizes the immediate practical aspects of these rules, and distinguishes them from the culture and institutional arrangements of the larger socio-technical system in which the technology is embedded (see *Social-Technical Systems: History and State-of-the-Art*). A socio-technical system includes rules, more precisely normative rules,

specifying the purposes of the technology, its appropriate applications, the appropriate legitimate owners and operators, how the results of applying the technology will be distributed, and so on. The distinction between the specific instruction set and the rules of the broader socio-technical system are not rigid, but the distinction is useful for analytical purposes.

A major advantage of the ASD approach, particularly its articulation of socio-cultural evolutionary theory, is that feedback between social systems and the biological and physical world is center stage, coming in the form of material (in particular, resource distributional) responses to the implementation of cultural rules and institutional arrangements.

1.1.5 Rule Governed Social Interactions Produce Concrete Outcomes and Developments

The outcomes and developments resulting from human interaction and games may be intended as well as unintended. They are the immediate payoffs and losses for those involved as well as more long-term consequences relating to the maintenance and transformation of social institutions, cultural formations, and other systems of rules. The likely outcomes associated with human activity not only promote certain actions and discourage others, for instance promoting cooperation or competition and conflict. But they feed into the processes of resource distribution and accumulation that play a structuring and selective role in future system development.

By structuring activity we mean that social action and its outcomes may be directed toward maintaining, modifying, or transforming norms, institutions, and other socio-cultural elements of social systems. Such structuring is not only the result of purposeful actions of social agents. Structuring also comes about as an unintended consequence of institutions and human activity. In addition, exogenous material and social factors impinging on social systems have structuring and re-structuring effects.

ASD's theory of social change focuses attention on the processes by which cultural elements and institutional arrangements, that is, social rule systems, are generated, selected, and transmitted or reproduced through human interaction. These selective processes themselves have important dynamics that influence the prevalence and persistence of various rules and, thus, cultural and institutional orders.

Social systems are incessantly dynamic because (1) exogenous factors change and impact on them, evoking internal restructuring, and (2) internal social activities and dynamics often entail learning, conflicts, and innovation, which lead to adaptations and transformations impacting on external environments. These structuring effects of action are represented in Figure 1. Human agents, through deliberative as well as spontaneous, contingent, activities alter the interaction conditions and selective environments significantly, as they adopt and implement new institutional arrangements and technologies that ultimately impact substantially on their social and physical environments. The changed environment means that the selective and structuring processes operate differently than they did prior to the changes initiated. This means that actions and interactions no longer have the same consequences as earlier. Strategies

that worked previously may no longer work, or work differently. And other strategies that were unsuitable or ineffective earlier may become fruitful. The institutional order of a social system may be viewed then as the macroscopic resultant of multiple, often contradictory, structuring and selective processes, including purposeful social action. Feedback loops, particularly multi-level feedback loops, make a social system potentially unstable.

ASD provides categories, principles, and a systematic basis, on which to generate particular empirically-oriented theories or models. In this way, a complex of interrelated and compatible theories has been developed, among others: (1) socio-cultural evolutionary theory, that is, the evolution of social rule complexes; (2) a rule-based approach to conceptualizing and analyzing social institutions and organizations and their dynamics; (3) a social rule-based theory of human agency stressing that rule-application or rule-following is the fundamental form of human action at the same time that actors adapt, reform, and replace some of the rules; (4) a generalization of game theory, distinguishing types of game rules that are conflated in the classical theory, and stressing that social rule complexes structure and regulate human interaction and games—that is, human interaction is conceptualized as more than simply a result of rational calculation; (5) a theory of human reflectivity and consciousness.

1.2 Social Rule System Theory: Institutions and Cultural Formations

Most human social activity—in all of its extraordinary variety—is organized and regulated by socially produced and reproduced rules and systems of rules. Rule processes, the making, interpretation, and implementation of social rules, as well as the reformulation and transformation of rules, are universal in human collectivities. Such processes are often accompanied by the mobilization and exercise of power, and by conflict and struggle. Social rules are, therefore, not transcendental abstractions but are embodied in the practices and institutions of groups and collectivities of people: language, customs and codes of conduct, norms, laws, and the social institutions of family, community, economic organization such as business enterprises, and government agencies. Individual and collective actors play a central role in the formation and evolution of social rule systems, although often not in the ways they expect or intend.

Human agents (individuals, groups, organizations, communities, and other collectivities) are the producers, carriers, and reformers of systems of social rules. They interpret, implement, adapt, and transform rules, sometimes in highly creative ways. Such behavior explains much cultural and institutional dynamics. Major struggles in human history revolve around the formation and reformation of core economic, administrative, and political institutions of society, the particular rule regimes defining social relationships, roles, rights and authority, obligations and duties, and the “rules of the game” in these and related domains. In such ways, normative and institutional innovation is generated.

The theory of rule systems enables one to systematically link disparate concepts within sociology and the social sciences: cultural formations and institutions, as rule complexes and symbol systems more or less known and utilized in their interactions by members of

a community or organization, they are the basis on which participants constitute and regulate patterns of activity and social order; authority and power relations; role schemes and relationships; and normative frames.

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Biographical Sketches

Tom R. Burns is Professor at the Department of Sociology, University of Uppsala, Uppsala, Sweden. He earned a B.Sc. with Honors in Physics at Stanford University. He went on to take his Ph.D. in Sociology, also at Stanford. He is the founder of the Uppsala Theory Circle at the Department of Sociology in Uppsala. Among his engagements, he has been a visiting Professor at the Wissenschaftszentrum Berlin (1985), Clarence J. Robinson University Professor at George Mason University (1987-1990), Fellow at Swedish Collegium for Advanced Study in the Social Sciences (Spring, 1992; Autumn, 1998), and Fellow at the European University Institute (Spring, 1998). Burns has published more than 10 books and numerous articles in the areas of social theory and methodology, socio-economics, institutional theory and analysis, a new theory of games and interaction, and evolutionary theory. His empirical research and publications are in the areas of politics, the sociology of technology and environment, and comparative analysis of institutions and organizations. Among his books are *Man, Decisions, Society* (1985), *The Shaping of Socio-economic Systems* (1986), *Creative Democracy* (1988), *Societal Decision-making: Democratic Challenges to State Technocracy* (1992), *Municipal Entrepreneurship and Energy Policy: A Five Nation Study of Politics, Innovation, and Social Change* (1994), *Transitions to Alternative Energy Systems: Entrepreneurs, New Technologies, and Social Change* (1984), and *Structuration: Economic and Social Change* (in Chinese) (2000).

Thomas Baumgartner is an environmental economist and a Senior Research Associate Natural and Social Science Interface, a unit in the Department of Environmental Sciences of the Swiss Federal Institute of Technology (ETH Zurich). He has published a number of books and numerous articles utilizing and developing the Theory of Actor-System-Dynamics and its transdisciplinary applications. His current research concentrates on methods and instruments for economic, social, environmental, and integrated assessments, techniques for evaluating and accounting of products, projects, technologies, and policymaking units. Further information can be found on <http://www.uns.umnw.ethz.ch/pers/baumgartner>.

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