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## A Stage-Theoretic Approach to Information Systems Planning in Existing Business Entities of Recently Established Market Economies

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### ABSTRACT

Recent experience with existing businesses in the newly added eastern states of Germany has shown a tendency toward the immediate (and often rash) acquisition of current information systems technology for the support of operations. In many cases, the lack of planning reflected in these actions has led to disappointments and subsequent requests for help. The scenario evinced by these situations is reminiscent of the principles espoused in Richard Nolan's stage hypothesis for information systems growth (1979). In this paper, possibilities are discussed for better understanding the unique set of circumstances presented by these situations, in light of the Nolan hypothesis, with a system dynamics approach.

### INFORMATION SYSTEMS IN THE NEW STATES OF GERMANY

The problems being faced by owners and managers of newly privatized eastern German firms are manifold. A general characterization can certainly claim that the challenges confronting them center largely around the immediate need to be competitive and profitable in a system whose ground rules are totally new. While no single problem area deserves to monopolize their attention, a significant priority in the eyes of many managers is the efficient and effective support of operational functions with current automated technology. With little institutional (or, for that matter, industry-wide) experience in the sudden adjustments this priority necessitates, many firms have nevertheless been forging ahead with ambitious entrepreneurial spirit. The operational and management considerations that deserve attention in the process are only now being discovered - often at the expense of unfulfilled expectations and lost opportunities.

Automated support of industrial and business functions is certainly nothing new in the eastern states of Germany. In the days of the German Democratic Republic (GDR) there existed a vast network of computer hardware and software specialists, whose accomplishments were abridged only by a lack of access to state-of-the-art tools. With a long-standing acceptance of the unreliability of repair or maintenance possibilities, most of these specialists became, out of necessity, experts in all aspects of supporting the systems with which they worked. Not an insignificant consequence of this circumstance, was the ability of most data processing shops to exercise unusual creativity in overcoming hardware and functional problems with software solutions (Löschke, 1991). This adaptability is showing itself to be a two-edged sword in the adjustments being made to the western information systems world. The prevailing orientation of the market economies to standardized software and hardware systems has fallen heavily on the traditional eastern German specialists' mistrust of such pre-packaged products - with reliability "only a phone call away". On the other hand,



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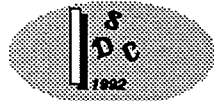
the customization of such products to the unique needs of particular users is being handled expertly and creatively in the eastern states, with little or no need of (costly) vendor support.

Organized systems development methodologies are also nothing new in the eastern states of Germany. For many years, the data processing (DP) shops in the old GDR produced "Organization-Ware" systems with the help of an analysis- and planning-oriented procedure called "Systematische Projekt Entwicklung" (SPE). Embodying all the processes and principles of a standard systems development life cycle methodology, this approach rivaled any procedure that came of age in the western information systems world. The problem that often surfaced, however, in the application of SPE was rooted in the virtual impossibility of implementing the carefully produced designs (Schmieglitz, 1992). Hardware and peripheral equipment availability was always in question and because of this, most rigorously conducted analysis and design projects fell by the wayside. The consequences of this situation have been manifested in the growth of a generation of information systems specialists whose originality and creativity was used largely in copying software systems from the western markets and adapting them to the unique (and often relatively strange) hardware configurations and functional requirements of their firms.

At present, the situation of existing private enterprise in the eastern states of Germany has two sides. Of the more than 10,500 enterprises that existed at the time of the reunification, over 1,000 have been privatized by management buyouts (entirely or mostly by and for the workers and managers who already populated their personnel charts) and some 5,000 or so have been sold to foreign or western-German investors or companies (Grünrock, 1992). Of the latter group, most have been the recipients of more than just the actual and promised investments from the outside. Those whose acquisition reflected the desire of a western firm to represent itself in the newly opening eastern markets have seen the parent firm's management methods and information systems be handed down from above. Those whose buyers consisted of investment groups have witnessed reorganization and restructuring efforts that also included immediate infusions of western-style information systems consulting and training. These firms stand to gain (at least initially) from the lessons learned in the last four decades by the western information systems community. It is the former group of independent enterprises which forms the central object of the research of this paper. These firms stand to learn from their own mistakes and benefit from their own diligence. The growth of information systems support for operations and decision-making in these firms will come largely from within.

The enterprises which have experienced successful privatization largely through their own initiatives are mostly small and middle-sized companies. Although the bases for generalized profiles are still anecdotal, it is fair to say that for most, their prior existence in the GDR was either as independent producers or as parts of larger conglomerates (Combinats). The myriad of problems they face today in adjustment to the market economy involve every traditional area of business pursuit: finance, accounting, tax, marketing, personnel, operations and strategy. While many operational procedures may still exist for producing the goods or services that these firms produce, the backdrop for all the processes has now completely changed. It is no small wonder that the managers of these enterprises are not currently concentrating their energies in long-term planning.

In fighting to survive their transitions to private enterprise, these companies often give short shrift to information needs analysis before succumbing to the temptations of a sales-oriented technology market (Schmieglitz, 1992). It appears to be the common scenario that such enterprises



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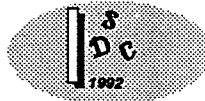
make arrangements to acquire current hardware and software systems as soon as it is possible and only later come to grips with the consequences of their purchase decisions. With some, the enthusiasm felt initially at the immediate availability of state-of-the-art technology is mitigated only after it becomes apparent that system capabilities and capacities have been overestimated. With others, the shock comes sooner, when managers realize that maintenance, upgrades and service do not come particularly cheap. In most cases, this technology is not ever thought of for support of any higher-level decision-making functions in an organization (Schmieglitz, 1992). Planning takes time -- and time is a luxury that most eastern German managers do not believe they can afford to invest in information systems planning.

The possibilities for business and information systems consulting help for these firms appear to be severely limited. The management in many of these enterprises show a desire to maintain a certain distance from western firms. In part, this witnesses the general feeling of wariness accompanying the drastic (and forced) change which people there have experienced since the reunification. It is sometimes a reaction to the sales-oriented approaches many have sustained in the last two years from western computer vendors. Managers in the eastern states also generally recognize that a fruitful consulting relationship should be a long-term one -- and the financial footing of many of their firms is shaky at best (Schmieglitz, 1992). The help that many of these firms are requesting (and receiving) comes largely from independent programmers who have training and experience from the old GDR context and have gone into business for themselves. As has been predicted by Göhlmann (1990), the immediate use of standard applications software packages is currently in full swing, and the installation and customization is being seen to by the many independent programmers who are now available. In Leipzig alone, some 300 small programming companies had registered with the state by August of 1991 (Löschke, 1991).

#### THE STAGE HYPOTHESIS OF RICHARD NOLAN

In 1973, Richard Nolan forwarded a stage theory for describing the growth of information systems (IS) within organizations, which had a profound impact on the information systems community. Characterized as an evolutionary theory, Nolan's hypothesis itself evolved in papers written during the following years, to culminate in 1979 with the final form of his hypothesis (Nolan, 1979). Nolan postulated the existence of six stages through which an organizational information system passes, in the course of its evolution to effective and efficient support of an organization's information needs. Called (1) Initiation, (2) Contagion, (3) Control, (4) Integration, (5) Data administration, and (6) Maturity, these stages represent, in the theory of Nolan, unavoidable phases of growth that are driven by technology. His theory provides benchmarks for diagnosing a firm's current standing within its progress through the stages and describes guidelines for managing that growth (to maturity) in a way which will minimize the occurrence of crisis situations and lost opportunities.

The stages of Nolan's model have received much description and analysis over the years. (In particular, see Lucas, 1977; Drury, 1983; and King & Kreamer, 1984.) With their help, the following description might reasonably characterize the stages. In Stage 1, computing is introduced to the organization. Some basic operational functions are automated and technology begins to achieve recognition as an agent of change in the organization. Control can be characterized as "lax" and planning is generally absent. In Stage 2, management encourages innovation in the application of the new technology to functional areas. This encouragement, together with the enthusiasm of certain users, leads to an explosion of new applications. Within this environment of expansion, a continued



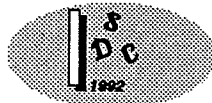
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absence of planning and controls results in poorly designed and non integrated applications. Stage 3 witnesses a retrenchment of sorts. While costs and expectations have continued to rise, the problems evinced by poor designs and controls hit hard. Severe controls are instituted and management realizes a need to emphasize centralized planning. The attention that the computer resource finally receives leads to a change in management thinking -- now regarding their task as one of managing the *data resources* of the organization, not the *computer resources*. A transition then takes place to Stage 4, where integrated systems and database principles take hold. Data processing costs continue to rise, but so do the visible benefits of these expenditures. In Stage 5, data administration becomes the management focus, characterized by careful controls and willing participation in the design of creative systems. Stage 6 witnesses the "completion" of the applications portfolio "and its structure mirrors the organization and the information flows in the company" (Nolan, 1979).

Nolan describes four key growth processes whose current states can be used to identify the stage in which an organizational information system finds itself. The applications portfolio, the management character of the DP organization, the state of planning and control practices, and the level of user awareness are variables which contribute to indicating a level of progress through the stages. These categories, together with expenditure and technology benchmarks, provide the basis for a model of diagnosis and prescription for information systems evolution. This model has enjoyed considerable popularity and acceptance among practitioners for describing and managing IS growth in organizations (Benbasat, Dexter, Drury and Goldstein, 1984). Indeed, the tenets of Nolan's theory seem to be showing themselves now in the early stages of the growth of organizational information systems in the new states of Germany.

Despite its apparent plausibility and its actual acceptance, Nolan's stage hypothesis has failed to achieve the approval of IS researchers. A number of empirical studies by researchers have failed to yield any formal evidence to verify its reliability or robustness. (For a good summary of many of these studies, see Benbasat, Dexter, Drury and Goldstein, 1984). They conclude that, while the theory represents a "coherent explanation of interrelated phenomena, ... the overall weight of accumulated evidence ... is non supportive ...". They suggest that, despite its intuitively appealing character, the theory may be empirically elusive. Although the hypothesis has not been validated by these studies, a number of them have produced empirical support for many of the constructs within it. Drury (1983), for instance, used a Likert scale to measure perceived IS problem areas in surveyed firms, in an attempt to find a correlation between their seriousness and the perceived standings of the firms within Nolan's six stages. Although the correlations reported did not uniformly agree with the expectations of Nolan's model, several factors were identified as being significant indicators of "information systems maturity."

The research connected with this paper is intended to investigate the complicated set of factors which have been shown to deserve consideration in the context of Nolan's theory. It is felt that the unique circumstances of newly privatized enterprises in the recently established market economy of eastern Germany provide an unusually clean field of study. Nolan accounted for the complicated IS histories of western firms, in efforts to analyze their evolutionary standing, by noting that different organizational units might have information systems that occupy different stages of maturity at any given time. It seems that such complications are of little consequence here -- most of the enterprises in this study are only just beginning to implement current IS-support technology. A major stumbling block on the way to stage analyses for western firms has always been in the measurement of psychological and attitudinal variables. It is anticipated that this field of study will



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largely involve only expectations, as opposed to experiences, in this regard. Of course, the circumstances surrounding the firms of this investigation will provide difficulties that are hard to predict. Since no functional area of a newly privatized firm is immune to the effects of the changes taking place, all processes and practices within these enterprises are evolving with the information systems intended to support them. This may contribute to an unclear picture in the minds of users of the requirements for such support. In general, the dynamic nature of the environment promises to challenge many attempts at categorizing individual variable values consistently.

#### A SYSTEM DYNAMICS MODEL FOR GETTING A GRIP ON THE SITUATION

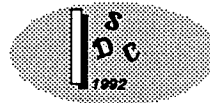
Precisely the dynamics of the circumstances under study have motivated the formulation of a system dynamics model for guiding their further investigation. Indeed, it is the dynamic and complicated nature of the situational variables that may have led to the prior failure of statistical methods, in attempts to capture an underlying structure. (Such statistical tools as correlation analysis, factor analysis, discriminant analysis and goodness of fit tests, with their required focuses on individual factors and pairs of factors, may have belied the complex and integrated nature of the variables in consideration.) The purpose of this modeling effort is to achieve a trusted characterization of the interplay between various factors that have been shown to be significant in indicating IS growth. The ultimate goal is to enable a comprehensive study of newly privatized eastern German enterprises, with a survey instrument that can reliably capture any tendencies which may exist in regard to the growth of IS.

The Nolan model was chosen as a basis for this investigation because the current situation seems to embody its intuitive principles. It provides a framework for beginning to understand the factors that are influencing the (largely reactive) management practices in the context described. Given the pressures and priorities with which management must operate in the newly privatized firms, it may be useful to have a set of recommended concentrations of attention in making decisions that guide IS growth. It may be the case that Nolan's hypothesis can be validated for this restricted set of subject firms. If the investigation is successful in verifying any generalized structure of desirable management activities, that will be enough. It is intended that, with the help of system dynamics, a comprehensive study can be operationalized, which is able to accommodate the implications of the many changes which are (and will continue to be) taking place in the interplay between significant factors.

Below, a general description is presented of the main level components of the system dynamics model, together with tested and planned representations of factors that influence the changes in the model's levels. Since validation and testing of this model are not yet complete, this paper offers only a general discussion of these components.

#### INFORMATION SYSTEMS SUPPORT FOR BUSINESS FUNCTIONS

To represent the process of IS growth or evolution in an organization, the model depicts the maximum potential for such growth, within the context of the organization's current business functions, the decisions to strive toward realizing that potential, and the successfully implemented support for business functions, which reflects the actual IS growth. The potential and actual information systems are given as levels, called Potential Support for Business Functions (PSBF) and Support for Business Functions (SBF), respectively. These levels may represent hardware, software,



or manual procedures, and are measured in arbitrarily fixed, abstract units of "IS support." The general convention for understanding and using such measurement units is adopted from similar methods used in models of technological innovation and adoption. (See, for instance, Milling, 1974.) It is assumed that all units of IS support which enter the model are of equal value to the firm, whether viewed in monetary terms or in terms of some other measure of IS support "usefulness". The magnitude, indeed the very measure for that magnitude, is immaterial -- we are interested here in the flow of these units from potential to actual levels, not in the precise interpretation of individual units.

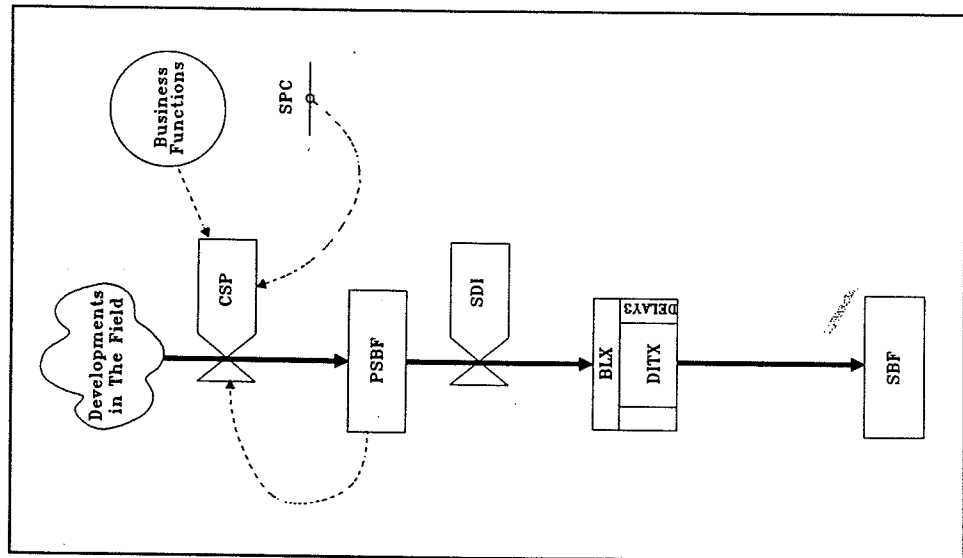


Figure 1. Information Systems Support for Business Functions

The potential IS support for business functions in an organization is certainly never a static quantity. The information requirements of a firm's business activities are always changing. External and internal factors contribute to the need for constant modification and enhancement of the organization's information systems. Additionally, changes in the available technology and advances in the areas of its application can also affect a firm's potential for increasing IS support to its business functions. In the model presented here, the PSBF level is also changing. Fed from outside the system by "Developments in the Field" (representing the current state of information systems technological and heuristic advances), the PSBF level grows at a rate which is governed by the information needs of the organization. As depicted in Figure 1, the CSP rate (Change in Support Potential) deems any aspect of IS innovation as "appropriate", if the business functions of the firm would (in anyone's wildest dreams) render it an improvement to the firm's current IS support portfolio. Changes in the information needs of a business can also bring about an increase in the level of potential IS support. If a program requires maintenance, for instance, this model will treat that as a slight increase in the level of IS support that could potentially be provided.

The flow of potential IS support units into the level of actual, implemented support for business functions (SBF) is regulated by a rate which represents both the user "demand pull" and the technology "supply push." Depicted in the model as SDI (Systems to be Developed and Implemented), this rate is intended to reflect user requests for systems development (new systems,

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system enhancements, modifications and maintenance), as well as management planning and controls (which can serve to accelerate or hinder the flow at any given time). As discussed below, in various versions of the model presented here, this rate has enjoyed the direct and indirect influence of all the model's components. An exponential delay provides an additional stumbling block for the units of IS support that have passed out of the PSBF level, on the way to actualization. Deciding to commit the resources to a systems development effort by no means assures its instant success. Depending on the development environment, a project could be delayed a long time, before its final product is implemented. A common situation with many firms, in fact, witnesses an IS development "backlog" of approved requests, and renders some developed systems obsolete before they are finally installed. The factors affecting this development delay in the various versions of the model have largely included the level of User Awareness (UA - described below) and the direct and indirect consequences of management planning and control priorities.

An important auxiliary variable for the support levels' interaction with the other model components is derived from the potential and actual IS support levels. Called Relative Support for Business Functions (RSBF), this simple ratio value offers management a surrogate view of where the firm stands in relation to its competitors in the area of information systems. With appropriate assumptions about the costs of running systems and the costs of development efforts, a similar measure can be derived for IS expenditures, at any given time, from the levels of IS units completed and under development.

#### USER AWARENESS

The second major flow in the model presented here takes place between levels of potential and actual "User Awareness". The concept of user awareness is central to the stage theory of Nolan (1979), in its diagnostic and its prescriptive components, and has also been empirically shown to be a significant factor in indicating information systems progress (Drury, 1983). As a level, it should be interpreted to include any aspects of satisfaction, optimism, expertise, training and experience, which might influence a user's interaction with the information systems and the IS management of the organization. Psychological levels such as this can be as important to understanding the functioning of complex business systems as levels of material goods (Forrester, 1961) and today enjoy the increasing attention of information system analysts, designers and researchers. As with the levels of IS support for business functions, the levels for Potential User Awareness (PUA) and actual User Awareness (UA) are measured in arbitrarily fixed, abstract units.

Figure 2 shows the flows connected with the model's user awareness section. External to the system exists the source of all potential user awareness. While not to be confused with analogous spiritual concepts, it can be viewed as an ideal setting that embodies all the positive behavioral influences which a user could have on the information systems objectives of an organization. At a rate (CPUA - Change in Potential User Awareness) which is proportional to the potential user awareness existing in the firm (PUA), the source feeds this potential awareness to establish a level of reasonable expectation for user awareness. The constant proportion has been set, in most versions of the model, to coincide with the constant which governs the change in business support potential (discussed earlier).

An exponential delay offers a hindrance to the immediate assimilation of potential user awareness by the organization. This reflects the time it may take before reasonably expecting that

user attitudes could change or knowledge could be assimilated, following a change in external conditions. When a technological breakthrough hits the market, for instance, it already represents an increase in the organization's potential for enhanced support of its business pursuits. It may take some time, however, before one can expect that the firm's users will become aware of its possible benefits. In the model discussed here, it is assumed that the advent of negative attitudes or dissatisfaction will be reflected by increases in the flow to PUA. Rather than allow the actual user awareness to show a decrease, an auxiliary "Relative User Awareness" (RUA) variable, derived from the ratio of actual to potential, is used as the primary means by which this section of the model influences the others. (An increase in PUA will cause a decrease in RUA.)

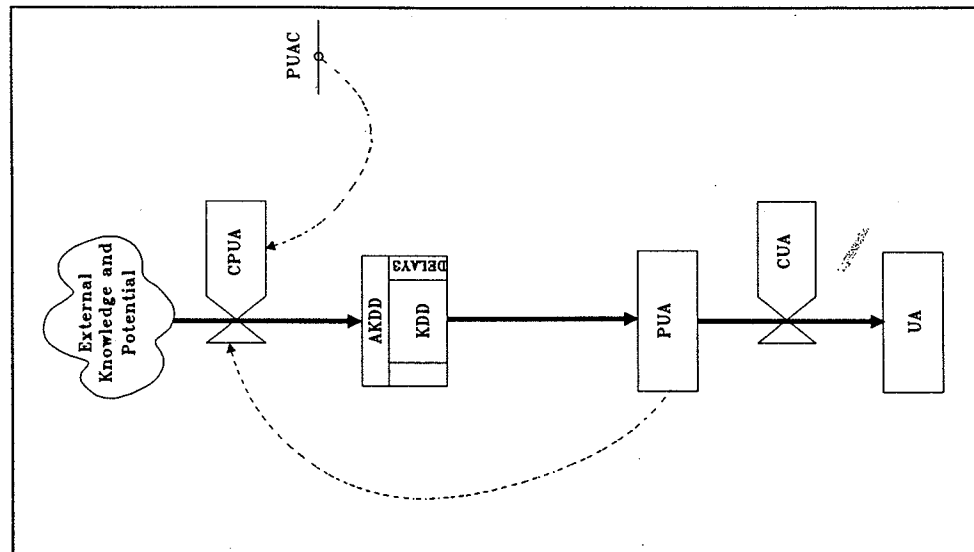
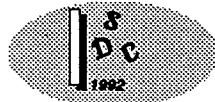


Figure 2. User Awareness

The flow of user awareness units from their potential to their actual levels is influenced in the various versions of this model by many factors. The rate which governs the flow, Change in User Awareness (CUA), is primarily a reflection of the environment created by management planning and control policies. Various representations have been considered for indicators of these policies. Some are briefly discussed below. These policies can themselves be indirectly affected by the prevailing level of user awareness (through the management reactions to IS successes and failures, for instance). In fact, the nested nature of many such possible interactions, whose plausibilities are evinced by empirical studies and intuitive feelings, has rendered the building and testing process for this model a tedious one. While specific characterizations of these relationships is beyond the scope of this paper, the following section discusses the management variables that are being explored as possible factors of influence in the interaction between and within the two model sections presented above.

#### MANAGEMENT ENVIRONMENT

The management environment section of the model is currently being designed as a collection of auxiliary variables which affect and are affected by the main level components of IS support and user awareness. Most of the variables explored are formulated and interpreted as probabilistic multipliers.





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A variable's effect on the rate of a particular flow is one of hindrance or encouragement, depending on the proximity of its value to 0 or 1.

The management conditions represented by these variables have been chosen through two approaches. The recommendation of Forrester (1961), that "factors to be included ... arise directly from the questions that are to be answered," has motivated the formulation of variables which may represent unique aspects of the management environment surrounding newly privatized German firms. Factors such as "Percentage of Attention Given to IS Concerns" and "Propensity to React to Information Needs" have been explored. The study of Drury (1983) has also motivated the formulation of management variables for this model. "Stability of the Development Environment," "Encouragement of Creative IS Solutions," "Encouragement of Risky Development Projects," and "Appropriateness of Control Policies" are a few of the factors that have been characterized for inclusion.

Management orientation is an important input to the underlying dynamic process. A goal of a validated model will be to test the effects of different management approaches. The management multipliers in the model are determined by the level variables RSBF and RUA, as well as various other derivatives of their levels. They, in turn, influence the decisions and delays that govern the flows in the model's two main sections.

Many of these variables show promise for representing intuitively pleasing influences on the model's flows. The overlapping of effects between these factors, which has also complicated the statistically-based empirical studies mentioned earlier, occurs here, too. While one should not expect that such behavioral constructs would ever exhibit mutual exclusivity of interpretation or influence on the system, the goals of this model do include the reasonable clarification of dynamic system behavior. In that light, the aggregation of variables recommended by Forrester (1961) is an important task for the further development of this section of the model.

#### REFERENCES

- Benbasat, I., A.S. Dexter, D.H. Drury, and R.C. Goldstein. 1984. A Critique of the Stage Hypothesis: Theory and Empirical Evidence. *Communications of the ACM* 27 (5): 456 - 475.
- Drury, D.H. 1983. An Empirical Assessment of the Stages of DP Growth. *MIS Quarterly*, June: 59 - 70.
- Forrester, J.W. 1969. *Industrial Dynamics*. Cambridge: MIT Press.
- Gibson, C.F. and R.L. Nolan. 1974. Managing the four stages of EDP growth. *Harvard Business Review*, January - February: 76 - 88.
- Göhlmann, H. 1990. Informationsverarbeitung in der DDR: Situation und Perspektiven. *Die CZ* August 8: 12.
- Grünrock, U. 1992. The Role of the Treuhandanstalt. Presentation at the 1992 Fulbright-Seminar, Berlin.



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- King, J.L. and K.L. Kraemer. 1984. Evolution and Organizational Information Systems: An Assessment of Nolan's Stage Model. *Communications of the ACM* 27 (5): 456 - 475.
- Löschke, K. 1991. Chancen und Risiken des Aufbaus einer PC-Technologie-orientierten Firma in den neuen Bundesländern. *PC's in kleinen und mittleren Unternehmen* ed. W. Remmele, Leipzig: Fachgruppe 2.0.1 der G.I.: 3 - 10.
- Lucas, H.C. and I.A. Sutton. 1977. The stage hypothesis S-curve: Some contradictory evidence. *Communications of the ACM* 20 (4): 254 - 259.
- Milling, P. 1974. *Der technische Fortschritt beim Produktionsprozeß: Ein dynamisches Modell für innovative Industrieunternehmen*. Wiesbaden: Dr. Th. Gabler.
- Nolan, R.L. 1973a. Managing the Computer Resource: A Stage Hypothesis. *Communications of the ACM* 16 (7): 399 - 405.
- Nolan, R.L. 1973b. Plight of the EDP manager. *Harvard Business Review* 51 (3): 143-152.
- Nolan, R.L. 1975. Thoughts about the fifth stage. *Database* 7 (2): 4 - 10.
- Nolan, R.L. 1977. Controlling the costs of data services. *Harvard Business Review* July - August: 114 -124.
- Nolan, R.L. 1979. Managing the crisis in data processing. *Harvard Business Review* 57 (1): 115 - 126.
- Schmieglitz, B. 1992. (Compass Computerhilfe, Berlin.) Personal interview.