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HUMAN ISSUES IN TECHNOLOGY IMPLEMENTATION MANAGEMENT SIMULATOR

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ABSTRACT

A common theme in the U.S. manufacturing sector is to seek improved organizational and national manufacturing competitiveness through the adoption of Advanced Manufacturing Technology (AMT). Unfortunately, as many as, 50 to 75 percent of these efforts result in failure. A primary cause of these failures has been identified as the lack of proper attention to the Human Issues in Technology Implementation (HITI).

This paper describes an addition to the currently limited existing body of knowledge and tools in this area, through the identification, analysis, and model formulation of the human issues involved in successful AMT implementation; and deployment of this knowledge through the development of a model based computerized Human Issues in Technology Implementation (HITI) management simulator.

With the HITI management simulator, organizations will experience the system dynamics of the human issues involved in implementing technology and be able to develop, test, and receive real time feedback on implementation strategies and tactics. This realistic low cost and no consequence implementation process and team building training will allow organizations to obtain a better understanding of the human issues in technology implementation. Through this better understanding, it is anticipated that the U.S. manufacturing sector will be able to execute more effective AMT implementations and improve both organizational and U.S. manufacturing competitiveness.

INTRODUCTION

A popular organizational strategy to improve long term manufacturing competitiveness is the adoption of advanced manufacturing technology (AMT). Consisting of computer numerically controlled machines (CNC), computer aided design (CAD). Computer aided manufacturing (CAM), computer integrated manufacturing (CIM), robotics, and flexible manufacturing systems (FMS); AMT has the potential to improve product quality, increase process flexibility, and reduce manufacturing cycle time. This improved capability results in greater customer responsiveness and lower manufacturing operating costs.

These advantages entice many organizations to adopt AMT, however, evaluations by Majchrzak (1988) and Saraph (1993) indicate that as much as 50 to 75 percent of these efforts fail. Majchrzak (1988), Rennels (1990), Ettkin (1990), and Hornsby (1990) attribute these failures to inadequate attention to the human element involved in the technology implementation efforts.

The successful implementation of AMT is clearly, a complex and dynamic process requiring a myriad of high consequence human issues decisions. Organizations contemplating the adoption of AMT must first be able to identify, analyze, and model these critical human issues. Even if this can be done, the organization is still faced with the considerable problem of transferring this information from paper to the real world. Clearly, the most effective means of taking advantage of this knowledge would be to actually perform technological implementations. The difficulty in this, is the high capital expense of adopting AMT and the consequences of failure. Thus, the ability to adopt AMT without consequence would appear to hold significant appeal to any organization seeking to enhance manufacturing competitiveness through an AMT implementation.

This paper describes an addition to the currently limited existing body of knowledge and tools in this area through the identification, analysis, and modal formulation of the human issues involved in successful AMT implementation; and the development of a modal based computerized Human Issues in Technology Implementation (HITI) management simulator. The completion of this work will be a means by which organizations anticipating the adoption of AMT, will be able to better understand the human issues in technology implementation through realistic low cost and no consequence computerized implementation process and team building training.

LITERATURE REVIEW

A review of the currant literature focused on phase 1) identifying the critical human issues in the implementation of advanced manufacturing technology and phase 2) relevant simulators.

Phase 1 of the literature search yielded a number of consistent concepts in the successful adoption of advanced manufacturing technology. The following issues appear to be critical elements necessary for successful technological implementations:

1) Use of a Human Centered philosophy which encompasses the concept of the computer aided craftsman, who is both supported by and in control of the technology.

2) Early and significant worker participation in the planning and selection of the technology.

3) Initial introduction of the technology by utilizing pilot projects to allow gradual exposure.

4) Presence of a technology implementation champion.

5) Employees are selected and trained to be more capable in terms of knowledge, skills, and attitudes.

6) The organization specifically directs training and education effort towards overcoming resistance to new technology.

7) Performance evaluation and rewards systems era changed to better suit the new technology.

8) Organizational design is changed with technology implementation (simultaneous engineering, production teams, crossfunctional teams).

9) Flexibility and responsiveness is improved by empowering workers to make decisions at the lowest level which has access to the necessary information.

Phase 2 of the literature search yielded three simulators relevant to Human Issues in Technology Implementation. Smith end Golden (1993) addresses the management of generic human resource departments in the Human Resources Management Simulation. Duke (1993) takes a strategic total enterprise approach of a complete manufacturing organization in the non-computerized game ADVANTIG. Lastly, Pray and Methe (1991, 1993) suggest the use of a computer simulator to train for the strategic management of radical changes in technology in a modified version of an existing simulator DECIDE and in a current work INNOVATE.

The simulators identified through the literature search take into primary consideration either human resource issues or technology implementation issues. Those which do address human issues do not take into account the effects of advanced manufacturing technology and those which address technology implementation issues do so on only a total enterprise level and do not consider specific human issues. A second limitation to these simulators is that they take a strategic, whole enterprise view over an extended period of time, an approach more appropriate for middle to top management level personnel. Lastly, participant performance for these simulators is primarily based on administrator sat parameters, rather than collected quantitative data.

No currently available computerized management training simulators take into account the detailed human issues specifically necessary for the successful implementation of advanced manufacturing technology. Thus, a clear and urgent need exists for the development of a micro level, model based Human Issues in Technology Implementation Management Simulator to allow low cost and no consequence implementation process learning and team building for any organization contemplating or anticipating the adoption of advanced manufacturing technology.

RESEARCH METHODOLOGY

This section describes the planned methodology for this project. The research consist of the following phases: 1) Collection of data to drive the HITI management simulator, 2) Development of the simulator model, and 3) Development of the model into a user friendly IBM PC based HITI management simulator.

Data Collection

A survey was designed to determine organizational practices with respect to the critical HITI. Data obtained from production administrations of the survey and subsequent focus will be used to drive the HITI management simulator. Face validity and continuous improvement of the packet was performed with the management, workforce, and union of a major U.S. automobile manufacturer. As of October 1993, the survey has been administered to two major aircraft manufacturers.

Model Development

Model development is expected to consist of the analysis of data obtained from the HITI survey and the construction of conceptual and mathematical models for the HITI Management Simulator. Individual survey response data is expected to be analyzed primarily through multiple regression analysis. The regression analysis will be performed on individual critical issues within a project life cycle framework as specified by Adams and Barndt (1983). For the purposes of the proposed work, the process of technology implementation is expected to include the conceptual, planning, and execution phases of normal project life cycles. As Cleland (1990) notes, management must make correspondingly dynamic responses to the ever-changing levels of cost, time, and performance, by changing the mix of resources assigned to the project as a whole and to its various work packages. Thus, certain issues are expected to significantly affect the implementation during each phase of the project.

By categorizing the critical HITI issues within the Life Cycle model activities, the significant HITI issues of each phase may be determined. During the conceptual phase, for example, the involvement of the work force would be critical, since basic planning for the implementation occurs during this phase. Conversely, changes in performance evaluation and pay systems would be meaningless since actual production has not yet occurred during this phase.

For a given phase of the implementation project, the success of the project is expected to be a function of the level of the presence of the applicable critical HITI (1):

$$\text{SUCCESS} = f\text{(presence of critical HITI)}$$

Initial attempts at data analysis will assume a simple multiplicative relationship between the presence of critical HITI and the importance of critical HITI to produce a “success factor” for each issue. Thus, for multiple regression analysis, the independent variables will consist of the success factors for each issue, while the dependent variable will be the success issue rating.

Decision Variables

The simulator model will incorporate initial, concurrent, and critical decision variables. Initial decision variables include implementation project time and cost specifications and startup resource level allocations for the critical HITI issues prior to the start of the simulator run. Concurrent decision variables will consist primarily of resource level allocations for the critical HITI issues during the implementation. Lastly, critical incident decision variables will involve resolution choices and special resource allocations to respond to events such as strikes, supplier failures, and accidents.

Performance Indicators

Continuous performance feedback for the simulator will be provided by both absolute and relative indicators. Absolute indicators will display the degree of effectiveness of participant effort in the implementation. The degree of effectiveness will be calculated against the base line of optimal resource allocation. Relative indicators will contrast current time and cost consumption versus the project schedule and the allocated budget.

Probabilistic Element

A basic criteria for the development of a simulator is the presence of randomness. For the HITI management simulator, randomness will appear in the form of the effectiveness of any decision and the presence of critical incidents such as supplier delays, equipment damage, strikes, etc. For decision effectiveness, assuming normality, the probabilistic element will be introduced using a uniform 10.11 random generator and the survey data multiple regression coefficients and standard errors. Critical incidents will appear according to user specified exponentially distributed interarrival times.

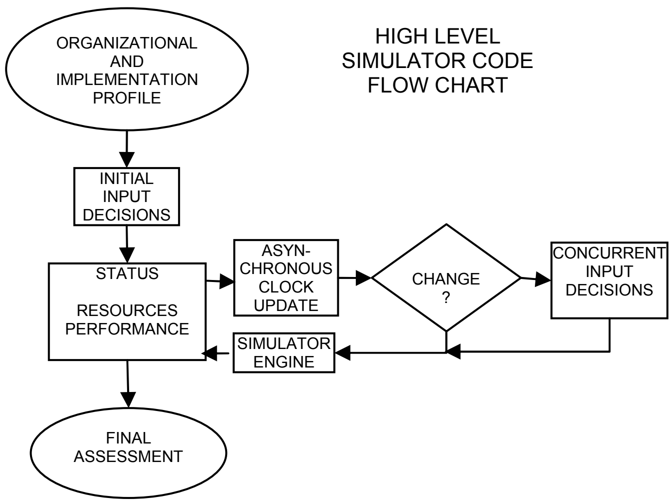
Simulator Code Development

A number of management simulators, including ADVANTIG ore non-computerized. Non-computerized simulators are usually dependent on trained administrators, require simulation specific support equipment, and exhibit limited interactivity. These limitations may adversely affect the real world usability of otherwise competent simulations. The low cost and user-friendly HITI Management Simulator software will maximize the opportunity for organizations to benefit from this research.

High Level Code Model

The high-level code model consists of the following components: organizational and implementation parameters, initial input decisions, real-time resource and performance status, asynchronous clock update, concurrent input decisions, and the simulator engine. These components are illustrated in figure 1 High Level Simulator Code Flow Chart. As can be seen from the figure, the simulator will initially present the organizational and implementation parameters screen. On completion of this section, the simulator will proceed to the initial input decision screen. When the initial decisions have been made, the simulator will begin the implementation run. The implementation status screen will be presented, providing detailed information on resources and performance measures. While the status is being displayed, the simulator will continuously update the time clock. The simulator will also monitor for user changes in the implementation decisions. If changes are desired, the simulator will display the concurrent input decision screen. If no changes are desired or when the changes are complete, the simulator will process the affects of the changes through the simulator engine. Resource and performance changes will then be updated to the status screen. When the implementation is complete or cannot continue, the simulator will proceed to the final analysis screen.

FIGURE 1
HIGH LEVEL SIMULATOR CODE FLOW CHART



Model Validation

On completion of the HITI management simulator, the software package will undergo model validation. The primary purpose of this activity will be to determine the effectiveness of the model to represent the human issues involved in the technology implementation process. The validation will be performed through small and medium sized manufacturers associated with the University of Pittsburgh Manufacturing Assistance Center.

CONCLUSIONS AND FUTURE WORK

The proposed computerized Human Issues in Technology Implementation Management Simulator is expected to assist organizations in successfully adopting advanced manufacturing technology. This will be accomplished by incorporating the knowledge gained from Human Issues in Technology Implementation research into a user-friendly management simulator software package. With the HITI Management Simulator, organizations will be able to experience, learn, and practice the process of adopting advanced manufacturing technology prior to actual implementation.

REFERENCES

Adams, John R. and Barndt, Stephen, "Behavioral Implications of the Project Life Cycle," David I. Cleland and William R. King (Eds.), Project Management Handbook, (New York: Van Nostrand Reinhold Co., 1983), p. 227.

Cleland, David I., Project Management Strategic Design and Implementation, (Blue Ridge Summit. PA: TAB Professional and Reference Books, 1990), p. 33.

Duke, Richard D.. Personal communication with, Multilogue, 321 Parklake Ave., Ann Arbor, Ml 48103, 19 August 1993

Ettkin, Lawrence P. and Helms, Marilyn M., and Haynes, Paula J., "People: A Critical Element of New Technology Implementation." Industrial Management Sept/Oct 1 990, Vol. 32 No. 5, pp. 27-29.

Hornsby H. Heyward and Williams C. Glyn CAM Still Needs People Business and Economic Review, Oct-Dec 1990. Vol. 37 No. 1, p. 26

Majchrzak, Ann, The Human Side of Factory Automation (San Francisco: Jossey-Bass, (1 988)

Pray. Thomas F. and Methe, David T.. "Modeling Radical Changed in Technology Within Strategy-Oriented Business Simulations," Simulation end Gaming, March 1991, Vol. 22 No. 1, pp. 19-35.

Pray, Thomas F., Personal communication with, Department of Decision Sciences, College of Business, Rochester Institute of Technology, Rochester, NY 14623-0887, tel. 716-475-2344, 20 August 1993

Proceedings of the 1990 International Industrial Engineering Conference, San Francisco, May 20-23, 1990, "Human Factor Aspects of Implementing New Technologies by E. Kenneth Rennels (Norcross, GA: l1E) pp. 318-322.

Saraph, Jayant V. and Sebastian, Richard J., "Human Resource Strategies for Effective Introduction of Advanced Manufacturing Technologies," Production and Inventory Management Journal, First Quarter 1992, Vol. 33. No. 1, PP. 64

Smith, Jerald, Human Resource Management Simulator, (New York: Prentice-Hall, 1993).

Smith, Jerald, Personal communication with, Ford Atlantic University, 29 June 1993