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THE DRAMA METHODOLOGY FOR ANALYSING STRATEGY AND ITS LINKS WITH PRODUCTION SYSTEM DESIGN

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ABSTRACT

The DRAMA process design methodology represents the principal output from a major programme of research conducted in collaboration with ICL, the UK's largest indigenous mainframe computer manufacturer.
DRAMA is based on the design and implementation of new manufacturing systems and the associated decision processes. It was developed from work carried out at ICL's main assembly plant at Ashton under Lyne where an integrated production system termed the 'Modular Assembly Cascade' had been introduced, hence the acronym Design Routine for Adopting Modular Assembly.

The DRAMA methodology is not rigid and mechanistic but can best be described as a set of 'guiding principles' that allows companies to analyse their competitive position and to design a production system relevant to their needs.

The design aspects of the methodology specifically relate to assembly operations within a market-driven business environment. However, the analytical components are more generic in nature and can be used in connection with the strategic analysis of a wide variety of manufacturing situations.

DRAMA is, therefore, being modified and extended to allow it to be used as a more generalised means of analysing strategy and its links with production system design. In this way a pair of methodologies has emerged: DRAMA I, being the original process design methodology, and DRAMA II its corollary (Decision Rules for Analysing Manufacturing Activities).

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INTRODUCTION

The DRAMA process design methodology was devised by a team from the Innovation, Design and Operations Management Research Unit at the Aston Business School. Its development constituted the principal activity in a three year programme of research supported by the Science and Engineering Research Council under its ACME (Application of Computers to Manufacturing Engineering) Directorate [1]. It is based upon the design and implementation of new manufacturing systems and the underlying decision processes.

International Computers Limited (ICL), the UK's largest indigenous manufacturer of mainframe computer products, was the main industrial collaborator in the research. Consequently, DRAMA was synthesised from empirical work which investigated process design activity at ICL's main assembly plant at Ashton-under-Lyne near Manchester over the period 1985-89. During this time an integrated production system termed the "Modular Assembly Cascade" was introduced [2][3], hence the acronym used for the resultant methodology ("Design Routine for Adopting Modular Assembly").

DRAMA is not a set of rigid and mechanistic prescriptions so does not propose to its users a limited panacea of procedures. It can best be described as an empirical collection of 'guiding principles' that allows companies to analyse their competitive position and thereby design a production system appropriate to their needs, based upon a number of feasible design options. The design aspects of the methodology relate specifically to electronic assembly operations within a market-driven business environment, being the context within which ICL operates [4]. However, the analytical components of the conceptual DRAMA model are generic in nature and can be used for analysing strategic manufacturing decisions over a range of operational and organizational situations.

DRAMA is now being modified and extended to facilitate its use as a generalised instrument for exploring hierarchies of organizational decision making and the links with production system design. Consequently, in addition to the original DRAMA process design methodology, its corollary, DRAMA II (Decision Rules for Analysing Manufacturing Activities), is now being developed for the analysis of manufacturing system design activities in general.

THE DEVELOPMENT OF DRAMA

Work on the SERC funded project entitled "Evaluation, Design and Implementation of High Variety Assembly Systems" started in January 1987. Two full-time research staff were employed, one a management scientist and the other an industrial engineer. They were allowed free access to ICL's Ashton-under-Lyne plant in order to conduct a comprehensive, longitudinal, study of the plant's decision and design processes. In order to observe these processes at first hand the researchers were absorbed into ICL Ashton's staff organization, to the extent of being treated by some ICL Ashton staff as fellow employees. Thus, an ethnographic investigation could be carried out whereby the research staff acted as 'participating observers' rather than merely being passive investigators. This approach enabled acceptance by ICL personnel and allowed the research team to gather data of higher quality than is normally possible with other types of industrial research.

The design and implementation processes for new assembly facilities were reconstructed and documented by the research team. This reconstruction was retrospective for the module implemented prior to the commencement of the research and concurrent for the developments being observed in 'real-time'. The longitudinal study of developments at the Ashton factory was complemented by a detailed organizational study of the Company as a whole. This explored the strategic choices made by the "Manufacturing and Logistics" division within the recently formulated market-driven corporate policy. It also considered how Ashton's sister plants within ICL had translated manufacturing strategy down to the level of production system design. Participative observation within Ashton was therefore supplemented by an extensive programme of semi-structured interviews throughout ICL, covering all levels of the organization from senior directors to shop floor employees.

External analyses were also conducted to consider customers, competitors and the technological, structural and business environment within which the Company was operating. Equipment vendor issues relevant to systems development were also explored. To place the ICL aspects of the research into context, supplementary studies were conducted in other companies manufacturing similar products for comparable markets.

From the data, a number of relationships were identified, tested and incorporated into the methodology where appropriate. Existing conceptual models from the literature were used at this stage to assist in the analysis of the observed decision processes [5][6][7][8]. Later these also provided a framework for DRAMA, the design and implementation methodology developed from the research [9][10].

THE DRAMA MODEL OF PRODUCTION SYSTEM DESIGN

Objective of the Model

The DRAMA methodology is essentially a set of guiding principles that assist the user to steer through the decision sequences that must be followed when designing a production system. It is based principally on electronics assembly [11]. However, the model upon which the methodology has been developed provides a structure which can be used as an analytical tool for examining the decision process associated with production system design across a wide range of industrial contexts. The DRAMA model, from which the design methodology and manual have evolved, takes the following form:

The DRAMA Components

The model disaggregates the total production system design activity into ten components. These are:

Market and Environment
Manufacturing Strategy;
Organization;
Justification;
Project Management;
Physical System Design;
Control and Integration;
Work Design;
Implementation; and
Evaluation.

DRAMA assumes a generally phase-wise progression through these components during a production system design project. However, it is recognised throughout that they are interdependent and that design decisions have an effect on preceding and subsequent components, thus initiating a myriad of feedback and feed-forward loops. This notion corresponds closely to Mintzberg's decision process model which sought to assign structure to the longitudinal process of strategic decision making [7].

The DRAMA manual provides a flexible, user-led guide for production system designers which is divided into the ten components of the model. The methodology section of the manual, which forms the prescriptive part of DRAMA, advocates the top-down progression from strategy formulation to detailed facility design and operation indicated by the model. However, linkages are recognised and an evaluation of the impact of design changes on the rest of the components is seen as fundamental to the success of any process design activity.

The 'Tracks'

The research material gathered during the project included detailed ICL case study data of an observational nature, supplemented by material from outside the collaborating company. This comprised information from other manufacturing

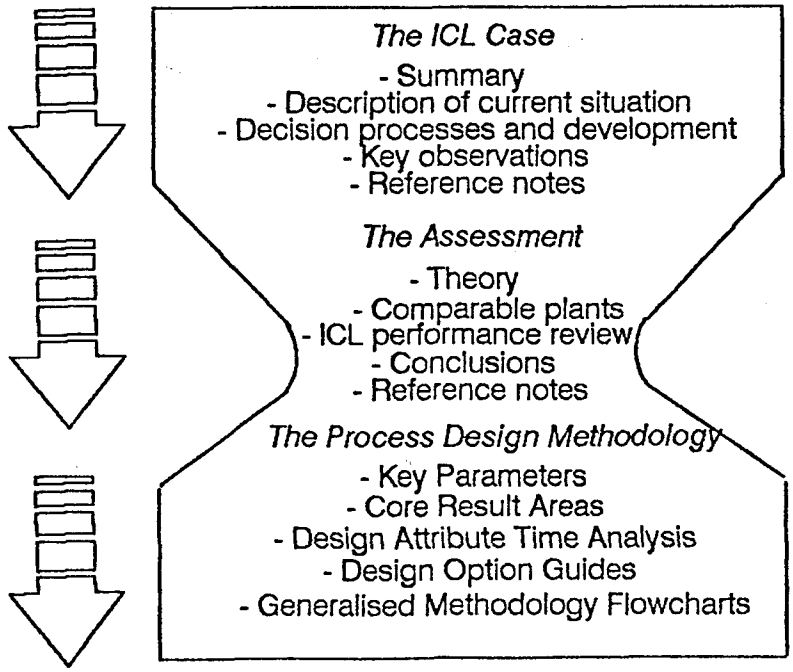
organizations, suppliers and customers together with details of the market and environment etc. Inclusion of the detailed case analysis in the manual was considered necessary to enhance the depth and quality of examination.

To allow the user to adopt a structured approach when following this material DRAMA is also separated horizontally into three tracks, namely:

(i) the Case;
(ii) an Assessment of the Case; and
(iii) the Generalised Methodology.

This not only enables the user to focus on specific components of interest in the design process, but also allows the opportunity to follow a particular aspect of each component without the need to read the complete manual. In this way it is possible to just select a descriptive case study, and/or an assessment of the case (with reference to theory, other organizations and established 'best practice'), and/or a methodology in the form of a set of guidelines which detail the design options available and their related positive and negative features. Figure 1 shows the conceptual form of each DRAMA component as it progresses through the case, assessment and design methodology tracks.

Figure 1 Conceptual Form of the DRAMA Components



The method of investigating the current context and detailed activities of a 'leading edge' organization and then relating this to practice elsewhere in the organization's industrial sector is a generally applicable approach to formulating

principles and guidelines for future design activity. Therefore the case to assessment to methodology route used by the DRAMA model is a useful means of analysing an organization's design process in order to provide lessons for the future.

Domains of Decision Making

DRAMA provides a model of organizational decision making which explores the effects of participation in the production system design process at different levels of the business. Three such levels or "domains" of decision making are identified:

(i) Strategic;
(ii) Tactical; and
(iii) Operational.

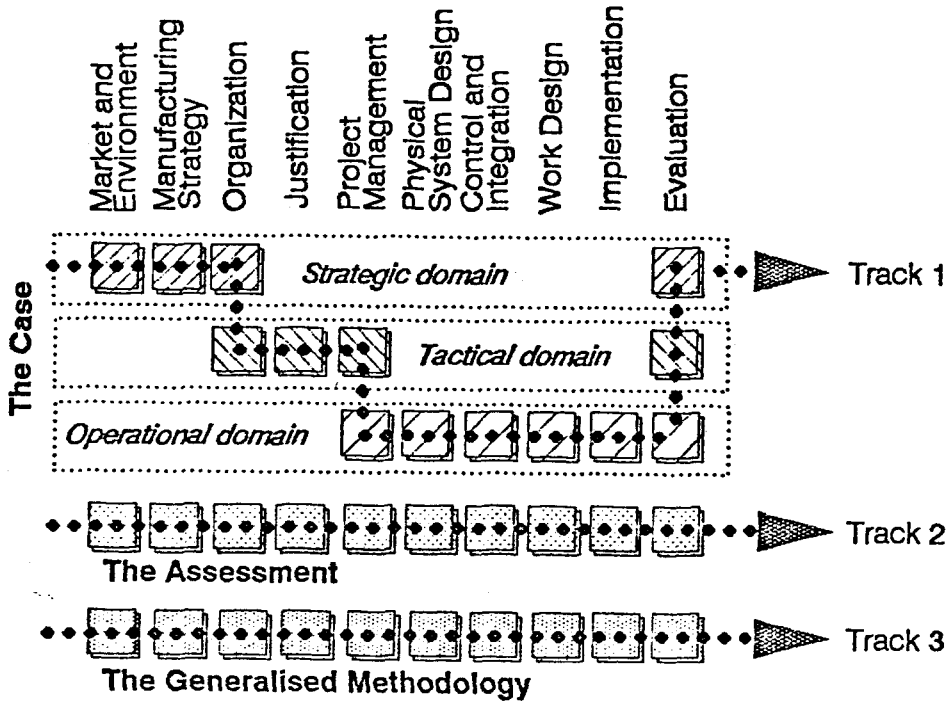
The *Strategic* domain embraces senior management decision making down to the level of individual plant units. Market and Environment, Manufacturing Strategy, Organization and Evaluation are identified as Strategic domain DRAMA components and can be considered together when focusing on strategic issues. The *Tactical* domain spans the middle management levels where senior management decisions are translated down into plant level procedures. Components falling within this domain are Organization, Justification, Project Management and Evaluation. The *Operational* domain relates to the lower organizational levels where detailed production decisions are taken. The Operational domain includes Project Management, Physical System Design, Control and Integration, Work Design, Implementation and Evaluation. Thus, it may be noted that Organization and Evaluation span the interface between the Strategic and Tactical domains, while Project Management and Evaluation span the Tactical and Operational domains.

This disaggregation of organizational decision making into three domains provides a hierarchical dimension to the DRAMA model to supplement the longitudinal analysis provided by the sequential components. Design activity and decision making can thereby and be tracked at different levels of organizational analysis as well as laterally through time.

Summary of the DRAMA Model

DRAMA is illustrated schematically in Figure 2, which places the concepts of components, tracks and domains into context within the model. The disaggregation of the design process into components and the recognition of decision domains allows both a longitudinal and hierarchical analysis to be conducted. It also permits separate consideration of each domain and/or component, while the input and output parameters of each component provide the linkages between strategy, tactics and operation.

Figure 2 The Components, Domains and Tracks of DRAMA

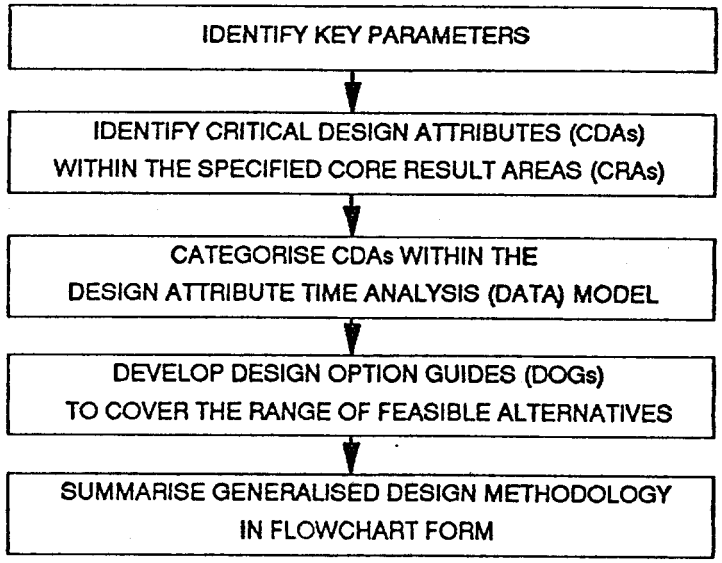


DRAMA AS A PROCESS DESIGN METHODOLOGY

The generalised methodology section of the DRAMA manual provides a detailed set of guidelines for companies wishing to adopt the concept of modular assembly. The methodology is suitable for the design of production facilities within the context of a market-driven corporate strategy requiring high variety, small batch manufacture.

Figure 3 illustrates the procedures followed when using the DRAMA methodology for each design component. The Key Parameters identified as inputs vary according to the particular component in question. They may be other DRAMA components or environmental factors such as the market, process technology etc. Critical Design Attributes (CDAs) are then listed for each component, categorised within a number of predefined Core Result Areas (CRAs) which are themselves dependent upon the domain within which the component's decision making process primarily operates. The variability of design attributes in relation to a time frame measure is determined by the Design Attribute Time Analysis (DATA) model which indicates on a three-tier hierarchical matrix whether the variability of design attributes is high or low against a short or long term time frame.

Figure 3 Development of a Process Design Methodology for a DRAMA Component



Having identified the Critical Design Attributes, the user is then guided through the available design choices for the component in question. Design Option Guides (DOGs) have been developed in conjunction with this aspect of the methodology. Here, the benefits and drawbacks of various design options are evaluated against a Principal Result Objective derived from a number of Result Criteria that are offered to the user. This iterative procedure permits the selection and modification of design options until the desired configuration is achieved. Finally, the generalised methodology is summarised in flowchart form to provide an overall representation of the decision process for each component. (For more detail, see [12]).

A particular feature of the methodology sections of the DRAMA manual is that they have been developed in conjunction with a description of the ICL case study and the experiences and lessons learned by other organizations when designing assembly systems. Its structure also ensures that the user considers the importance of coordinating all functions of the business and of understanding the relationship between different levels of organizational decision making.

DRAMA II: AN ANALYTICAL TOOL FOR LINKING STRATEGY WITH SYSTEM DESIGN

Extending the scope of DRAMA

It needs to be stressed that the detailed methodology originally developed, being largely based on a specific case, has more limited generic applicability than one which is based on a wider source of data. However, the structure of the underlying model (components, domains and tracks) offers the potential for DRAMA to have more generic applicability for linking corporate and manufacturing strategy analysis and the formulation of production system designs. DRAMA's use as a generic tool for analysing manufacturing activities is facilitated by structuring each part of the model in a manner that allows a systematic and logical approach to be taken when using it to investigate decision processes associated with the design and implementation of manufacturing facilities.

Since the original DRAMA acronym was derived from "Design Routine for Adopting Modular Assembly", its continued use in connection with a more generic tool was inappropriate. The extended methodology is therefore called DRAMA II ("Decision Rules for Analysing Manufacturing Activities").

DRAMA II offers the potential for both researchers and practitioners to model the design and decision processes for translating strategies at the higher levels of organization into physical system design, implementation and operation. As such, it provides a means of assessing how manufacturing strategies shape the design of operations and, conversely, how evaluation of existing systems and design projects can help shape strategic decisions following their evaluation.

The Context of Existing Theory on Manufacturing Strategy

In the past a common attitude among academics and industrialists was that strategy was something that accountants and marketing specialists dealt with to the exclusion of manufacturing managers. Production personnel were simply not involved with strategy formulation and analysis; rather they concentrated the operational planning and control of activities with a limited time horizon.

Since the work of Skinner in the 1970s [13], there have been numerous calls for the design of manufacturing operations to be considered as an important element in the corporate strategy of an organization. Harvard Business Review took up the theme and published several articles on the importance of manufacturing strategy in the early 1980s [14][15][16]. The work of Michael Porter also demonstrates how corporate management texts can provide lessons for manufacturing managers wishing to adopt a top-down and market-orientated approach to operations [17]. Others have also advocated the virtues of deriving competitive advantage from the approach to manufacturing manufacturing taken by exemplars [18][19].

These works must be acknowledged in that they have raised the profile of manufacturing within organizations and have highlighted the importance of manufacturing within corporate strategy. However they tend to be largely promotional and do not usually provide a detailed structure and prescription for the detailed analysis of manufacturing decision making.

The work of Hill goes further by considering how to manage operations with a strategic perspective [20]. He compares manufacturing management practice and performance in an international context and then provides lessons for the translation of corporate policy and market strategy into process choice and the development of a manufacturing infrastructure. Previously, Wild [21] had considered the role of manufacturing in business policy and set up a policy framework which included the interaction of the operations management function with the external environment at all levels.

In a similar way the more recent work of the Cambridge group [22] proposes that an organization should start with a strategic view of the business as a whole and, in turn, develop a business strategy, product strategy and manufacturing strategy prior to planning the manufacturing facilities. Hill and the Cambridge group provide an interesting insight into the activity of strategy formulation and translation, but they adhere rigidly to an overtly top-down and market deterministic view of manufacturing system development. A further criticism is that they say very little on the subject of human resource management and organization which, it goes without saying, constitute crucial factors in the success of any manufacturing strategy.

As far as the link with production system design is concerned, there have been few attempts to translate manufacturing strategy into decision processes for technology and work organization. Exceptions to this are Hill, who addresses the matter in his chapter on process choice and Kantrow's aptly named article "The strategy-technology connection" [23]. More recently Schroeder has considered the impact of production system technology on the development of corporate strategy [24].

Linking Strategy with Production System Design Using DRAMA II

DRAMA II assists in understanding the relationship between corporate strategy and the design of operations systems by offering an empirical model for analysis which incorporates all levels of manufacturing decision making.

The incorporation of a number of existing models and systems design approaches in the development of DRAMA II means that the basic model is multi-perspective. DRAMA II advocates an open systems approach in the analysis of components in the higher domains of managerial decision making, while a closed systems approach is adopted when progressing down to the lower domains. This fits well with the Kast and Rosenweig notion [25] of a

"hierarchy of systems" approaches whereby higher levels of socio-technical analysis demand a more open approach.

The research methodology employed when developing and using the DRAMA model borrowed from Checkland's soft systems approach [6] with its movement and feedback between the real and abstract world. A soft systems approach would also be relevant whenever the realities of actual human decision making are being considered as is the case when using DRAMA II.

DRAMA II's hierarchical dimension, which allows for a high degree of structural analysis, is derived from the conceptual form of the GRAI model [8]. This is complemented by a longitudinal, 'through time' dimension which evolved following the use of Mintzberg's model [7] for analysing unstructured strategic decisions, which allows for lateral analysis of the decision making and design processes when developing new production systems.

DRAMA II, like most manufacturing strategy theory, advocates a top-down and market-driven approach to strategy formulation and its translation to the level of operational design. However it also recognises more readily than most other theories that bottom-up and lateral forces are extremely important in shaping and evolving strategy.

DRAMA II also recognises a correlation between the production system design process and a phase-wise and cyclical movement through the model's components, from "Market and Environment" to "Evaluation" and back. It recognises that there exists a host of interconnects between components, both within the same domain (eg: simultaneous consideration of the "Physical System", "Control and Integration" and "Work Design") and hierarchically (eg: "Organization" affecting "Manufacturing Strategy" and the functional design of the operational system).

The research that underpins the development of DRAMA II is distinctive compared with most research in the area which tends to consider manufacturing from a senior management perspective. The DRAMA project covered this aspect with its programme of senior management interviews, but largely comprised a longitudinal, and even in many ways bottom-up, analysis of a manufacturing company that was looking to articulate a newly formulated market-driven strategy at the level of the physical system. It was only by using this method of enquiry that the investigators were able to identify the existence and nature of feedback and feed-forward information that permeated the Organization during the five year development of a new production system.

DRAMA II's principal asset, therefore, is that it offers a comprehensive framework of enquiry when considering the design of a production system. It recognises direct and indirect linkages between the market and strategy in the higher domains of

organizational decision making and the decision making processes that occur in the tactical and operational levels. It offers a flexible model by virtue of its modular design which enables the design process to be divided into a number of separate components.

Finally, use of the underlying model in developing the DRAMA manual for high volume, low variety electronics assembly system design illustrates how a detailed, industry specific, methodology for operations design can be developed through a longitudinal case study supplemented by reference to theory and an assessment of best practice in the sector. The methodology can then be evolved as a set of guiding principles highlighting the viable options and their related features.

CONCLUSION

DRAMA II, "Decision Rules for Analysing Manufacturing Activities", addresses the need for a practical model which offers a framework of enquiry linking a strategic analysis to the design of production systems. Its flexibility, which is derived from a modular structure, allows users to select and focus on those components of the design process that are of immediate concern to them. The model was used for the development of the DRAMA manual for electronics assembly system design and illustrates how the underlying model can be used to develop an industry specific methodology.

DRAMA II has evolved as part of a detailed research project where a case analysis was conducted using participative observation spanning three years. The result is a model which displays realism and recognises both the hierarchical and longitudinal nature of decision making when designing production systems.

This paper has described the development of DRAMA, a design methodology for high variety electronics assembly, into DRAMA II which is a model for use as an analytical tool for studying organizational decision processes during the design and implementation of production systems. DRAMA II is currently being tested in a number of organizational and sectoral contexts both within and outside the limits suggested by the original ICL case. The outcome of this further research will determine the future direction in developing the model.

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