Achieving agility using cladistics: an evolutionary analysis

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Abstract

To achieve the status of an agile manufacturer, organisations need to clearly understand the concept of agility, relative to their industrial and business circumstances and to then identify and acquire the appropriate characteristics which will result in an agile manufacturing organisation. This paper is not simply another discussion on the definition of agility, or a philosophical debate on the drivers and characteristics of agility. This paper presents an evolutionary modelling technique (cladistics) which could enable organisations to systematically manage and understand the emergence of new manufacturing forms within their business environment. This fundamental, but important insight is valuable for achieving successful organisational design and change. Thus, regardless of the industrial sector, managers could use cladistics as an evolutionary analysis technique for determining “where they have been and where they are now”.

Moving from a non-agile manufacture to an agile manufacture is a process of organisational change and evolutionary development. This evolutionary method will enable organisations to understand the landscape of manufacturing possibilities that exist, to identify appropriate agile forms and to successfully navigate that landscape. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

The characteristics of an agile manufacturing organisation are widely associated with companies who operate in the aerospace and automotive sectors. Many organisations which exist and operate outside of these sectors, believe that the industrial and organisational differences between the automotive/aerospace sectors and their industry, are so great and inherent, that they prohibit the transfer of ideas and lessons from one sector to another.

A recent committee meeting of the metals rolling industry was planning a seminar on the concepts of agility and the reference to the metals rolling industry. At this meeting there was justified confusion and scepticism about the term “agile” and its value to the metals rolling industry. The concerns raised by the Committee centred around the following three questions:

1. What exactly is agile manufacturing and how does it differ from other manufacturing initiatives such as lean manufacturing and responsive manufacturing?
2. Is agile manufacturing really appropriate for the metals rolling industry, because the reported case studies and research programmes tend to be with manufacturing organisations that produce discrete products?
3. If there are lessons to be learnt on achieving agility within our industry, how do we identify and apply those lessons?

The above questions are common and are used to downplay the appropriateness and value of a new manufacturing initiative, but they are realistic and important questions which need to be tackled to ensure that any change programme is successful. This paper presents a methodology for manufacturing organisations, which addresses the above concerns. It uses an evolutionary technique to create a framework which can clearly identify the characteristics of agility, which are appropriate for certain industries and business needs, and to help companies identify their position relative to the desired position. The output of the framework, the cladogram, provides knowledge which could enable the formulation of clear and fitting action for either best practice imitation (mimetic strategy) or the innovation of a new organisational form (normative strategy). Manufacturing managers could become “evolutionary pathfinders”, using this framework to plan, develop and reinforce organisational structures, technologies, strategies and processes for improving a manufacturing organisation’s effectiveness.

Many researchers study manufacturing diversity by reflecting on the past to understand the events which
produced the organisational differences. Cladistics is used primarily by biologists to understand the diversity of life, and thus produce classifications, which are the basis and reference for their scientific enquiries. The stimulus for this paper is the desire to produce a well-defined theoretical, evolutionary classification of manufacturing organisations. Such a classification shows the evolutionary lineages between manufacturing eras such as craft, lean and agile. This classification could be the fundamental reference system for conducting academic studies of manufacturing organisations which could potentially provide the transparent evidence and answers to the questions concerning: What exactly is agile manufacturing? How does it differ from previous manufacturing initiatives? Is it appropriate for our industry and if there are lessons to be learnt, how do we identify and apply those lessons?

2. Why classify manufacturing organisations?

Understanding the different forms of manufacturing organisations that exist is a common introduction, found in many of the leading papers on agility. Many use a basic and informal assessment, to demonstrate how agile manufacturing differs from previous manufacturing initiatives such as craft production, mass production, focused production and lean production. For example, Booth [1] produced a bar chart entitled “evolution of manufacturing”, where seven different manufacturing forms are compared, using three scales: (i) economy, (ii) responsiveness and (iii) flexibility. Booth describes the transition between each manufacturing form in terms of an organisation’s approach to costs, volumes, variety, labour policies and customer/supplier relationships. This commentary about manufacturing forms is a process of classification.

Kasardar and Rondinelli [2] discuss the innovative infrastructures that should be in place to promote agility and thus enable the emergence of this new way of working. The introduction within this paper concentrates on establishing, where did agility come from, what does it mean and who first coined the term? Roth [3] describes how companies will achieve strategic agility by developing economies of knowledge. Before advocating any form of change, the paper advises managers to address the following questions: (i) The beliefs concerning the competitive landscape and the differentiating priorities? (ii) How are work processes modified, changed and evaluated? and (iii) How are the sources of value-adding changing? To answer these questions, the paper studies the evolving management perspectives and Roth claims that “the trajectory of the dominant paradigms of production logic and best practices can be understood by using a strategic map to look back to production’s historical roots and to help recognise its major disconnects between today’s and tomorrow’s passages”. Kuhn [4] provides a model of paradigmatic change, he talks about the emergence of new paradigms as periods of revolution, where new paradigms replace existing paradigms. Burgess [5] builds on the influential work of Kuhn, by proposing that stage models are useful for describing the changes from one major paradigm to another. The models presented by Burgess concentrate on the production systems and technology, which have enabled the paradigm shift between mass and lean production.

Finally, the popular and influential text “the machine that changed the world” [6] played a significant role in promoting the concept of leanness in manufacturing. This was achieved by providing a discussion on the different forms of automobile manufacturing that have emerged over the years (a simple classification). Such historical or evolutionary accounts provide powerful insights for understanding the various manufacturing approaches that have existed and for comprehending the new approaches that are materialising.

This process of understanding and classifying manufacturing diversity is taxonomy, whereby a person identifies new groups of manufacturing organisations (taxa = groups) and labels the groups according to their defining characteristics (nomy = naming) [7].

The above examples, which debate manufacturing initiatives and their accompanying forms using an informal classification, have brought many benefits in terms of understanding and dissemination, but they also have many limitations. For instance, there is common agreement on the definition of the attributes of a just-in-time manufacturing system (see, e.g., [8,9]). These definitions, however, are sufficiently vague to cause confusion with the terms flexible manufacturing systems, agile manufacturing systems, world-class manufacturing systems and lean manufacturing systems. This problem has been identified by many researchers and is summarised by the following quote: “(...) the diversity involved in the manufacturing industry is such that it is unlikely that all industry types should be aiming for the same procedures, policies and culture. Yet there has been very little research which tries to identify what the term world-class (WC) means for certain industry types. This leaves the current apparently poor performers with inadequate information to decide whether they are really not of WC standard, and, if not, insufficient appropriate guidance to determine how to achieve the WC goals to which most would agree to aspire” [10]. Endorsing this view is the UK’s Engineering and Physical Sciences Research Council [11] which raised the issue about whether new emergent forms of manufacturing organisation (fractal, virtual and holonic manufacturing organisations) actually existed and if they did how were they different from established forms of manufacturing organisation.

In addition to the above broad and simple classifications, numerous others more formal have been created. For a review of these classifications, the reader is referred to [7,12,13]. These existing classifications present a detailed understanding of the entity, but make no reference to, or apply the techniques or knowledge from the science of classification. A limited exception is where Barber and

2.1. Introduction to cladistics

As reported by McCarthy [16], the cladistic school of classification involves studying the evolutionary relationships between entities with reference to the common ancestry of the group. Constructing a classification using evolutionary relationships is considered beneficial, because the classification will be unique and unambiguous. This is because evolution is actual and mankind is currently unable to change evolutionary history, thus providing the classification with an external reference point. With phenetic classifications there is no such reference point and thus in the words of Ridley, “Cladism is theoretically the best justified system of classification. It has a deep philosophic justification which phenetic and evolutionary classifications lack”.

Reviews of the three schools of classification assess the schools on their ability to produce natural and objective classifications, rather than artificial and subjective classifications [17–19]. Cladistics satisfies both these criteria, as the entities within a cladistic classification will resemble each other in terms of the defining characteristics and the non-defining characteristics (characteristics not used to represent the phylogenetic relationships). Cladistics conforms to the criteria of objectivity because it represents a real unambiguous and natural property of the entity (evolutionary relationships) and thus different rational people working independently should be able to agree on a classification. This does not mean that there will never be valid disagreements between independent investigators. Such disagreements will occur, but they will centre on the assumptions and character data, and not the underlying philosophy. One of the greatest strengths of the cladistic approach is that the representation of the classification (the cladogram), illustrates the data, assumptions and results, making all decisions transparent.

In summary, a cladistic classification of manufacturing organisations is a system for conducting, documenting and co-ordinating comparative studies of manufacturing organisations. Thus, for achieving agility, cladistics could provide the consensus for formally approving, validating and typifying the emergence of agility within manufacturing organisations. Cladograms could represent the landscape (the diversity of competitive forms) for a manufacturing industry, thus providing knowledge and observations on the patterns of the distributed characteristics exhibited by manufacturing organisations over their evolutionary development. Yusuf et al. [18] note that “there is yet no company that is truly agile in the sense of having acquired all the essential characteristics identified in the growing body of literature on agile manufacturing”. The use of cladograms in the implementation of agile manufacturing could provide the information for understanding what agility means for each organisation. Therefore, the manufacturing organisations will be able to adopt the missing characteristics and eventually become agile.

This evolutionary analysis of organisations is superseding traditional approaches to problem solving and is strongly associated with studies, which treat organisations as complex adaptive systems (CASs). This new perspective could lead to profitable hypotheses about the macro- and micro-evolutionary mechanisms, which influence manufacturing competitiveness and survival. Such comprehension cannot be used to extrapolate the future, but it does inform you of where you are and how you got there, and this information is vital for any organisation intending to embark on a journey of change towards agility.

3. Evolutionary dynamics of manufacturing organisations

Agile manufacturing is not simply concerned with being flexible and responsive to current demands, although that is an obvious and defining property. It requires an organisation and an industry to evolve. If the need for change stems from chaotic markets then it is likely, almost common sense, that organisations should be treated as complex evolving systems. Like nature, manufacturing companies and the industries they exist within, have evolutionary dynamics, which tend to result in irreversible events whereby new ways of working and technology supersede redundant processes. Manufacturing companies are organisational systems and as such, conform to the thinking and knowledge on how organisational systems exist and evolve. To apply evolutionary models outside biology, you need to know what evolution is in the context of the entities under study (manufacturing organisations) and the domain in which they exist (industrial and economic ecosystem).

It should be noted that the terms manufacturing initiative and manufacturing form or type, are used on interchangeable basis within this paper, because the manufacturing initiative plays a significant role in creating the new manufacturing form. This creation process is referred to by Lumsden and Singh [19] as organisational speciation, i.e. the creation of a new breed of manufacturing organisation.

The words, ecology, emergence and evolution are now appearing regularly in manufacturing papers, which debate competitiveness and new ways of working. It was commonly accepted that the way to study manufacturing organisations was by focusing on the adaptive change which occurs within the company. This meant that as the environment changed, the leading manufacturing organisations in that environment modified their organisational forms, by embracing new technology, new ways of working and acquiring new corporate cultures. This purely adaptive approach was then accompanied by a selection approach to studying manufacturing organisations. This is when selection occurs principally through competition among the alternative novel forms that exist, and organisations in the environment select those
forms, which are best suited for maintaining survival. After the selection approach was introduced [20,21], several key texts have emerged to support and consolidate the importance of organisational ecology and evolution [22–24]. These concepts and the assumptions that accompany them attempt to understand the forces which determine which organisational form is viable for a certain environment; the mechanisms which exist to preserve organisational forms and the mechanisms which are passed from one generation of organisations to another.

Many new manufacturing initiatives are associated with the term revolution, because the proposed degree of change is radical and the promised benefits enormous. This concept and the use of the term is a myth, because evolution is used to describe prolonged periods of growth, whilst revolution is used to describe those periods of substantial turmoil. Van der Erve [25] supports this argument by stating “what we do not appreciate sufficiently, however, is that a transformation should be revolutionary in result, but evolutionary in execution”.

Thus, studying manufacturing organisations as complex, dynamic, evolving systems using an evolutionary technique such as cladistics, would appear to be both a natural and rational approach. McCarthy et al. [14] stated that such a study would depend on the agreement that manufacturing organisations are evolving entities and a general consensus on the following:

- **Manufacturing systems evolve and have ancestors.** This is evident by the way historians portray the advancement of manufacturing companies from prehistoric man with his tools, to ancient workshops, to the guild of craftsmen, to the cottage industries and to factories which eventually became mechanised and automated.

- **Manufacturing systems speciate.** The Ford Motor Company is described today as a lean producer, but its history demonstrates that it once was a craft shop, which developed into an intensive mass producer. This suggests that the Ford manufacturing plants have gone through at least two speciation events to produce new “breeds of organisation”.

- **Manufacturing systems are subject to the theory of natural selection.** This concept is supported by Hannan and Freeman [26], who believe that selection pressures force organisations to imitate the successful organisations, the result being a reduction in organisational diversity and a net increase of a particular type of organisational form.

4. Organisational change and cladograms

This discussion provides a description of how to interpret the information contained within a cladogram to enable organisational leaders to transform their companies successfully. It also provides an overview of the seven steps that are used to construct a manufacturing cladogram.

4.1. The cladogram

A cladogram is tree-like in appearance. This tree structure represents the evolutionary history, the diversity and the relationships between different manufacturing forms. The network of branches on the tree are the evolutionary paths that have accompanied organisational change programmes. Each path is formed according to the acquisition and polarity of certain characters (manufacturing characteristics that can be new technology, working practices, plant layout, etc.).

Fig. 1 shows a group of manufacturing organisations consisting just in time systems, flexible manufacturing systems, Toyota production system, lean producers, and agile producers. This figure is a section from the master cladogram of automotive assembly plants [7].

It is important to note that this was a pioneering study and that many of the types of manufacturing organisation proposed in Fig. 1 will not be known to the reader. This is not because they are newly formed types of manufacturing organisation, but rather that the automobile industry has not been studied using the cladistic approach. Every effort has been made to assign names, which describe the defining characteristics of the manufacturing type and where possible existing terms such as craft, mass, agile and lean have been used. Thus, the names given to the manufacturing forms are simply for the purpose of differentiation and communication.

The numbers shown on the branches of Fig. 1 denote manufacturing characteristics (characters) which have been adopted in order to survive and compete. Table 1 outlines a list of these characters.

To illustrate the use of the cladogram, the effect of the acquisition of character “11” (employee innovation prizes) on the manufacturing system will be explained. Character 11
4.2. Building a manufacturing cladogram

The proposed framework for constructing a cladistic classification of manufacturing organisations has been identified and adapted from classic biological approaches to cladism [30,31]. A detailed account of how to build a manufacturing cladogram is a paper in its own right and is beyond the scope of this paper, thus the reader is referred to [7]. A summary of the framework and its seven stages are given below. The seven stages of the cladistic framework are as follows.

4.2.1. Select the manufacturing clade

The starting point is to define the industrial sector to be studied. Within the cladistics context this sector is called the clade. The definition given by the biologists to this term is “(…) A group of organisms that exists in nature as a result of evolution and includes an ancestral species (i.e.) and all of its descendants. The members of the clade share a set of common ancestry relationships not shared with any other species placed outside the group (…).” [16].

Therefore, within a manufacturing context the term clade could be defined as “a group of manufacturing organisations that exists in an organisational environment (market segments, geographical departments, etc.) not shared with any other species placed outside the group”.

Classifications based on industry differentiation are widely used and accepted and are difficult to ignore. The automobile assembly industry (the clade) was selected, because it exists as a population of manufacturing organisations (species) that make and sell a closely related set of well-defined products. It is an industry, which is widely known and studied, and this provides benefits in terms of communicating, disseminating and validating the research. It is also a relatively young industry which has been extensively documented and this makes the investigation into evolutionary relationships relatively easy.

4.2.2. Determine the characters (manufacturing characteristics)

Once an industrial sector has been selected a number of different types of manufacturing organisation would appear to be a member of that clade (mass, lean, agile, craft, job, etc.), but the complete membership of the clade is not known. In fact a primary objective of a cladistic study is to identify all the members of the clade. This is a process of “mining for species”, whereby evidence is sought which will suggest the possible existence of a particular type of manufacturing organisation. This evidence tends to be in the form of published material or archives, which describe

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Matrix of characteristics of cladogram shown in Fig. 2</th>
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<tr>
<td>8</td>
<td>Pull procurement planning</td>
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<tr>
<td>11</td>
<td>Employee innovation prizes</td>
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<tr>
<td>12</td>
<td>Job rotation</td>
</tr>
<tr>
<td>15</td>
<td>Exchange of workers with suppliers</td>
</tr>
<tr>
<td>23</td>
<td>Open book policy with suppliers. Sharing of cost data and profits</td>
</tr>
<tr>
<td>27</td>
<td>TQM sourcing. Suppliers selected on the basis of quality</td>
</tr>
<tr>
<td>29</td>
<td>U-shape layout</td>
</tr>
<tr>
<td>35</td>
<td>Toyota verification of assembly line (TVAL)</td>
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<tr>
<td>43</td>
<td>Agile automation for different products</td>
</tr>
<tr>
<td>49</td>
<td>Employees are system developers. If motivated and managed they can solve problems and create value</td>
</tr>
<tr>
<td>51</td>
<td>Parallel processing (in equipment)</td>
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<tr>
<td>54</td>
<td>Open and responsive technology systems</td>
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<td>55</td>
<td>Customer driven</td>
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<td>56</td>
<td>Adaptive, knowledge-based processes</td>
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<td>57</td>
<td>Make to order</td>
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the advent of new ways of working and new breeds of organisation.

4.2.3. Code characters

Once a set of manufacturing organisations has been identified, along with the set of the defining manufacturing characteristics, the relationship between the characteristics and the organisations is examined to allow the construction of the cladogram. A cladogram can be constructed from the character data, because a cladistic character has three properties: direction, order and polarity [32]. The coding of a character facilitates the processing of the character set. Ordering is that property of a character, which refers to the possible character change sequences that can occur. The character property, direction, refers to the transition between the character states. When an investigator determines the actual direction of transformation the character is said to have a “polarised” state.

4.2.4. Establish character polarity

This task consists of determining the primitive (i.e. those characteristics which are present in an ancestral species) and derived (i.e. those characters which are not present in an ancestral species) characters from the comparison of different groups. At the end of this task, the order of character evolution and emergence could be defined so as to establish the sequence of organisational form across time.

4.2.5. Construct conceptual cladogram

This step involves the construction of the original cladogram based on the data already collected. Various tools exist to construct cladograms, which provide a “best estimate” of the evolutionary relationships contained within the data matrix. For a detailed account of these tools, see [33].

4.2.6. Construct factual cladogram

This stage involves studying real and existing manufacturing organisations in order to observe the manufacturing systems, which they operate. This typically consists of plant inspections, discussions with employees, assessment of planning and control procedures and assessment of documentation (annual reports, business plans and surveys, etc.). The study aims to validate the existence of the characters identified during the previous stages. It will test the validity of any proposed tree structure by ensuring that the character data matrix is complete (i.e. no important historical events which relate to characters have been omitted) and that the assigned polarity is correct. This stage is to an extent, validation by dissemination, because the factual data will be used to verify the conceptual data. The validity of any proposed tree structure will also be tested by allocating existing organisations a position on the cladogram. Thus, any lean producers should be able to locate themselves on the cladograms after this stage and clearly understand the characteristics that may have to acquire in order to become agile.

4.2.7. Taxa nomenclature

Finally, taxa nomenclature consists of naming each individual taxon located at the branch of the tree.

5. Application of cladistics

This paper is concerned with presenting ideas and information on how cladistics could help manufacturing organisations achieve agility. The first half of the paper gave reasons why we classify and understand manufacturing diversity. It then went on to introduce the cladistics method. Section 5.1 is a discussion on the potential practical and academic applications. The discussion centres around the argument that cladistics is a formal and established process for analysing and understanding evolutionary development. The information contained within a cladogram is firstly a catalogue of manufacturing diversity and this provides a theoretical framework, which underpins the knowledge on the processes, and events that govern organisational change. With this knowledge on evolutionary change and manufacturing diversity it is possible to create agile-based survival strategies and to identify the most appropriate and parsimonious path to achieving this agile status, and to distinguish between situations requiring morphogenic change and morphostatic change.

5.1. Academic applications

Before discussing the practical applications of cladistics, it is important to address the knowledge and understanding that this method offers. Successful applications emerge from this understanding.

5.1.1. Understanding agile manufacturing and the associated diversity (organisational systematics)

Despite the need for knowledge on the evolution of new manufacturing forms, as described in the previous section of this paper, no theoretical consensus exists for organising and supporting the vast number of empirical studies that examine industrial and organisational diversity. Using a systematic and comparative method such as cladistics permits an assessment of the generality of the attributes of complex systems [34]. Cladistic classifications and the desire to develop a theory of organisational differences could play a significant role in explaining the processes by which the practices and structures of organisations and organisational forms persist and exist over time. This application of cladistics is a prerequisite for understanding exactly what agile manufacturing is for certain industries and how agile manufacturing differs from other manufacturing forms. The complete set of characteristics for an agile manufacturing organisation would clearly be shown on the network of branches, which lead to an agile manufacturing organisation. A cladogram would also illustrate how an agile manufacturing organisation is different from its most...
recent ancestor (lean producers), by noting the characteristics on the branch which splits between agile producers and lean producers. In summary, the cladistic method is capable of addressing one of the fundamental problems of actually achieving agility, as described by [32]: “One of the fundamental problems that we face today in the design of agile manufacturing enterprises is a lack of a theoretical basis. In other engineering disciplines there is always some basic theory to work with, to provide insight and a conceptual framework. For example, electrical engineers have Ohm’s law and other circuit theorems, and mechanical engineers have Hook’s law, theories of bending, motion and so on. In the manufacturing engineering profession, all we have had in the past are the precepts of Frederick Taylor”.

5.1.2. Understanding agility within an industrial ecology context

Once we know why we have a diversity of manufacturing, i.e., why have been the manufacturing characteristics which differentiate the various forms of manufacturing, the next stage is to understand how this diversity successfully emerged. This question focuses on the organisational processes (e.g., replication, mutation, entrepreneurship, competition and natural selection) and organisational events (e.g., birth, death, transformation, speciation and extinction). These processes and events are central to the process of achieving manufacturing agility since they clarify its mechanics.

5.2. Industrial applications

In the context of manufacturing management and organisational science, the industrial interests focus on the strategic tools and on the techniques involving the implementation of organisational change. This paper proposes that cladistics could provide an assessment tool for the applied strategy and also it could aid the development of a change program that will lead them to agility. In addition, it could enhance the effectiveness of the classical benchmarking techniques for achieving agility (Fig. 2).

5.2.1. Creating strategies for agility

“Despite the popularity of flexible manufacturing systems, managers suffer from inadequate frameworks to help incorporate flexibility into their strategic planning” [35].

Manufacturing organisations will survive by inheriting, imitating and searching strategy trait (designing and adapting to new manufacturing configurations) to produce a desired outcome (measurable or immeasurable) such as profit, customer satisfaction, growth, return on investment, etc. Cladistics provides an interesting measure of strategic excellence through the principle of parsimony. The principle of parsimony is universally used in model building: when two alternative models explain a phenomenon equally well, the simplest model is preferred.

Strategic management is a discipline which was under close scrutiny in the 1980s and many researchers questioned if a correlation could be found between the practice of strategic management and organisational performance, usually defined as profitability. Although some researchers confirmed the existence of such a correlation [36,37], strategic management is concerned with the long-term sustainability of profits and thus strategic excellence can be difficult to define.

If there is agreement with the statement that “(...) successful firms have followed more than one route to successful redesign” [38], then the principle of parsimony could offer a legitimate definition of strategic excellence. Researchers can easily question, posteriori, how parsimonious the strategy of a firm was. The Toyota Motor Company demonstrates a remarkable record of excellent strategic practices, with the highly focused introduction of the Toyota production system [40], and its subsequent evolution toward lean production. On the other hand, the Ford Motor Company has wandered around in almost all the species of the automotive assembly plant cladogram, which infers a non-parasimonious evolution, and thus, a waste of corporate resources. Cladistics could be used to develop a set of performance measures, which would govern the strategic decision making process within companies.

Strategic planning is an attempt to reconfigure the organisation by both acquiring and dropping characteristics. Character dropping would appear to take two forms: natural phylogenetic reversal and reactive reversal. Phylogenetic reversal occurs as an unavoidable consequence of evolution. Reactive character reversal occurs when organisations realise that they have to alter their form because they have reached the end of an inappropriate evolutionary path. This change process results in the organisation acquiring and reversing the necessary character states. Since reactive reversals are not parsimonious and they are not included in the cladogram, they are a measure of a manufacturing organisation’s lack of strategic focus.

5.2.2. Agile manufacturing and organisational change

“(...) an attempt was made to identify a general implementation sequence. However, similar to the observation made by [39], a general implementation
pattern for the JIT practices could not be established” [9].

The above quote although concerned with JIT is familiar to organisations that have embarked on any organisational change program. A common difficulty associated with change initiatives such as agile manufacturing is that it is rarely understood that the inability to achieve an agile manufacturing status may be due to a mismatch between current manufacturing characteristics (the characters on a manufacturing organisation’s current branch) and the desired manufacturing characteristics, whether the characteristics be human, organisational or technical. That is, it is not simply a case of understanding the concept and key characteristics of an agile manufacturing organisation and then setting about implementing these characteristics. More often certain characteristics have to be removed or “unlearned” first, before the organisation can even begin to journey towards agility. Thus, a cladogram provides a clear and simple specification of a change sequence. It indicates the sequence by which characteristics should be either dropped or adopted. If there is agreement that the cladogram has been constructed according to the rules of parsimony, the physical and financial cost of the identified change route would be minimised.

The tree-like nature of a cladogram could be compared to a map, which once constructed provides organisations with an unambiguous and precise definition of the starting point of the change journey. If the journey is a mimetic process then it will involve initially travelling up a branch in order to drop certain characteristics and this would be followed by a downward journey towards the branch which signifies the desired manufacturing form. However, this should not be considered as an attempt to oversimplify the change process. Organisational change usually involves a stage during which the organisation has to “replace” the previous way of thinking and working with some new, more effective ones. Cladistics may depict the path that the organisation will have to follow in order to accelerate and improve the change process.

5.2.3. Benchmarking for agility

Fernandez [41] has developed a seven-stage tool, for evolutionary benchmarking, which uses the cladistic classification as a source of information for benchmarking application. This technique benefits from the advantages of the classical benchmarking techniques (incorporation of business practices, measure of business performance relative to other businesses, etc.) and from the generality achieved from the use of the evolutionary classification technique cladistics.

Evolutionary benchmarking may be used in the assessment of the implementation of agile manufacturing. The cladogram may provide all the necessary information for clarifying the meaning of agility for each organisation. Therefore, when assessing the success of the implementation it may provide an effective checklist.

6. Summary

Cladistics, as with all classifications, is a method for systematically organising knowledge about a population of entities. It is a process for studying diversity and attempting to identify, and understand laws and relationships that explain the evolution and existence of the variety of groups. Its intellectual and practical value is derived from this ability to explain and the tools and knowledge that could help organisations to be pro-active in the manipulation of their evolution. Since cladistics is a classification method, which ties its definition of similarity to naturally occurring change processes, the result is that the information contained within a cladogram is useful for identifying standard change sequences.

Cladistics may provide the organisations that wish to become agile a tool for understanding what agility means for them and how they can parsimoniously achieve the “agile status”. It could help them to both create and evaluate the strategy that has to be created by depicting the path that has to be followed on the cladogram.

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