CO-DEVELOPMENT: A CASE STUDY LINKING WORK FROM THE AUTOMOTIVE SECTOR WITH THE CONSTRUCTION INDUSTRY

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Construction and automotive occupy premier positions in the UK economy and much work has been carried out seeking areas where best practice could be transferred. The Cogent Co-Development programme was £3M tri-partite initiative between Cranfield University, Nissan European Technology Centre-Europe and its suppliers. The programme focused upon supplier-in-the-loop design that engaged with over 130 supplier companies and 1000 personnel working on the design/development process for a new vehicle. Three researchers spent three years working with Nissan Technical Design Centre Europe and their key suppliers across Europe in design activity-led workshops that resulted in a reduction of 30% in design time, 40% in design cost, and in excess of 30% in the cost of manufactured parts. Following this programme, a pilot programme with two main construction companies tested the use of the Cogent learning from automotive and established that there were common factors across the sectors. The need for consistency within an organization before engaging in collaborative design activity with suppliers was found to be a key requirement, with the outputs from both programmes providing indicators on the different ways that the two sectors manage the design involvement/cost/reward equation and their supplier relationship management processes.

Keywords: collaboration, design, measurement, partnering, relationship.

INTRODUCTION

The UK automotive industry has undergone considerable change since the arrival in the 1970's of the Japanese manufacturers. Within less than two decades, the nature of vehicle production has changed dramatically, new models are now being introduced in three years rather than five, quality and reliability standards have soared. Features originally thought of as extras have become standard fittings at no extra cost. The traditional Design Offices and manufacturing units of the vehicle manufacturers have been transformed into highly efficient assembly plants for the major pre-assembled modules of a motor vehicle, which are now manufactured and designed offsite by the supplier. Annual cost reduction rather than cost increase has become the norm.

The size and importance of the automotive and construction sectors make comparisons of performance a compelling study. The construction and automotive manufacturing industries are the two largest sectors of the UK economy; automotive represents 15% of the UK's manufacturing output, employing over 700,000 people, and construction generates 10% of the country's Gross Domestic Product, with an employment of just over 1.5million. Automotive sales are over £40Bn; with construction spend approximately £30Bn. DTI (2002). However over the last thirty years the dynamics and key characteristics of the two industries have increasingly

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diverged, one being forced to embrace change almost continually reacting to the effects of globalization, the other accepting that some change was necessary, but finding difficulty in bringing together effectively the many parties involved.

Automotive has substantially reduced its cost base over the last two decades, led by the Japanese transplant operations and their focus upon lean production techniques. Annual cost reductions are now a contractual part of supply and the internal cost reduction process embedded as a way of life throughout the whole supply chain. When the reliability, performance, running costs and added features are factored into a new car built today, comparison with a vehicle from the 80's demonstrates the dramatic improvement achieved.

A comparison of the performance of the UK construction industry with other countries indicates that the UK lags behind in performance, yet to date the numerous reports highlighting the problems (Latham, 1994, Egan, 1998 & 2002) and subsequent Government funded initiatives created to assist with a solution have, at best, had modest success. The 2002 Construction Annual Statistics show the UK to have higher unit costs than virtually all of its European partners (DTI 2002, Tables 15.4, 15.5), with the lead time on structural steelwork for example having marginally risen over the last 10 years. (Table 14.7), and building tender price inflation has averaged 4% per annum over the last 9 years.

THE NEED TO MOVE ON FROM LEAN PRODUCTION

By the mid 90's lean production processes had been successfully embedded in most of the major automotive manufacturers (VM's), but the competitive pressure on the VM's had not abated. The major elements of *muda*, or waste had already been removed from automotive manufacturing processes, but Nissan Technology Centre – Europe knew that to retain their competitive edge and continue to win internal orders for new vehicle models it needed to:-

- Cut its design time by 30%,
- Cut its design cost by 40%,
- Cut the cost of manufactured parts by 30%,

The context of the need for this improvement was set against its position already as the most efficient vehicle manufacturer in Europe, and that the improvements were measured against Japanese benchmarks of performance. Nissan's pioneering efforts in supplier development and supplier relationships had already resulted in world class levels of manufacturing quality, cost and delivery but constant improvement was still an expectation of both Nissan and its suppliers.

With over 70% of the cost of a vehicle resident in the supply chain, Nissan knew that the majority of the improvement resource needed to be focused at supplier level. The research team was asked to assist with a supplier development activity, but after initial discussions and visits to key Tier 1[1] suppliers, who by now were responsible for the majority of the design of their product, the expected large list of improvement activities did not materialise – the companies were also working at "world class" manufacturing performance level. From this point the strategy became one of

[1] Tier 1 suppliers feed assemblies of components such as dashboards, interiors, axles and sub frames directly to the VM at the point of assembly using just-in-time techniques to cut inventory and reduce required storage space.

building a closer working relationship between the VM and its Tier 1's to generate savings through co-development activities **within the design phase**, and over the next three years over 1000 employees from 100+ Tier 1 companies across Europe participated in Cogent workshops.

THE COGENT PROGRAMME

The Cogent Programme Design Methodology

Using knowledge gained from other researchers looking at Concurrent Engineering and supplier-VM interaction in product development (Wheelwright & Clark 1992, Clark & Fujimoto 1991, Kamath & Liker 1994, Littler & Leverick 1993) a programme design emerged, based upon three principles:-

- The use workshops and a non-critical environment to increase early co-operation
- Workshop / improvement activities based around a real problem, being tackled in real time (in this case the design of the Almera replacement)
- The setting of specific challenging targets for improvement that created a need to "think of different ways of doing things".

The programme focused upon three main activity areas, which were seen as key to gaining the commitment from suppliers to participate fully in a programme with such challenging targets:-

- Aligning the design processes between VM and supplier
- Joint improvement planning activities
- Protected profit margins[2]

The initial workshop was designed for Managing Directors of key suppliers, the principal objective was to gain top management commitment, and create comfort that other companies were in a similar situation to their own. The plan was to work initially with 7 suppliers, covering all spectra of ownership (UK, Europe, USA and Japan), size (large to small) and competence (good, poor and mediocre) as scored by Nissan's existing supplier performance measurement tool[3] to test out the robustness of the workshop design. The whole programme consisted of 8 workshops, with workshops for groups of company technical directors and engineering directors following a similar pattern to the MD session, and then an individual company senior management workshop followed, based at the supplier site to increase openness and allow more supplier staff to participate. Where there were specific technical or project management issues to resolve, additional, specific workshops were designed and facilitated by Cranfield personnel. Each company nominated a "Cogent champion" who was the focus for the improvement activity and acted in a support capacity to team leaders in applying Cogent principles and the teamworking approach. Key additional roles for champions included the identification of areas of conflict and facilitation of their resolution and looking for process improvements, but the champion was **not** responsible for decisions or steering the direction of the improvement team(s). The tension of a "real time" programme meant that there was

[2] With open book accounting and target cost prices with protected profit margin both parties seek ways of reducing costs to meet targets. Savings in excess of target are shared in pre-agreed proportions.
[3] During the Cogent programme the measurement tool was re-built to improve its objectivity

total commitment by participants, which raised and maintained energy and enthusiasm levels, and the setting of targets that could not be achieved by traditional cost and time reduction techniques forced attendees to challenge conventional wisdom and seek radical answers to problems encountered.

Key Features and Findings from the Cogent Programme

The workshops were based upon activities, with presentation time regulated to 20% maximum. Activities included general discussions about co-development issues, process mapping, measurement and performance analysis, and perception mapping. Each workshop sought to generate *specific improvement actions* for the participants. Identifying issues, prioritizing root cause and planning solutions were undertaken by **both** organizations, with many of the actions involving changes to the Nissan part of the development process. The concept of alignment was found to be a key factor to improving performance, both internally within an organization, and externally between two organizations working together. This area will be expanded later with the research work in construction.

The main findings were

1. The key implementation issue is how to align two competent organizations and processes – it is **not** about how to conduct remedial improvement of one partner or their processes.
2. Face-to-face communications are a necessary and effective way to create momentum and the initial step-change in co-development performance.
3. A robust, transparent and objective performance measurement system is an important component of a self-sustaining continuous improvement toolkit.
4. Suppliers are able to manage their relationships, whether partnership or adversarial, providing there is strong consistency in the VM.
5. Internal alignment of the customer is a pre-requisite of any co-development improvement.
6. The concept of alignment assists organizations in holding joint discussions about identifying improvements (as it is non-critical of either partner).
7. The contrast between old and new roles in the industry can lead to conflict
8. Supplier performance was higher than expected.

Cranfield's original role was meant to be the design, development and validation of the workshop process, after which the process would become an internal Nissan process. An important finding, which had a strong affect on the project plan and resource management, was the suppliers' stated desire to have continued third party facilitation. The literature failed to predict this, although after more data collection and with hindsight the use of third party facilitation is recognised as helping to generally increase the atmosphere of trust in a workshop. The psychologist in the team of researchers was able to explain this phenomenon from Kelly's personal construct theory (Kelly 1966) which suggests that when the physical presence of a facilitator without any perceived bias is combined with a **lack** of specialist knowledge it can create a comfort to share difficult information and can act as a reminder of the **strong common background** of the participants. When faced with a challenging target the presence of a subject-naïve facilitator tended to encourage the two subject-expert

groups to want to work together, “as like-minded engineers” to rise to the challenge, and share information to achieve the task.

It is worth reiterating that one of the key findings was that the vast majority of supplier improvement actions generated within the Cogent initiative were **not** remedial actions to improve basic development capability with the supplier, but activities to improve the synchronization of the design processes of both organizations and the encouragement to share and exchange data earlier.

COGENT AND CONSTRUCTION

Testing the Cogent methodology in Construction

One of the key Cranfield Cogent researchers took up a post with the Building Research Establishment at the conclusion of the project and it seemed a logical progression to see what parts of the Cogent learning could be applied within construction. An 8-month scoping study was funded by the Engineering and Physical Sciences Research Council, and focused upon design/development activity with two major UK construction companies. The two collaborating companies differed in their structure, with neither being typical contractors winning the majority of their work via competitive tender; one was a major property developer controlling the majority of the design construction and facilities management process, the other was closer to the traditional contractor model, but gained the majority of its work via negotiation and long-term procurement agreements.

The main differences between the sectors that the research highlighted were:-

1. The companies required concurrent engineering/internal product development expertise before any engagement in supplier development activity could begin.
2. Both companies were not ready to bring suppliers into their design process within the time period of the scoping study and confirmed a key output from Cogent in automotive that internal alignment is a pre-requisite before commencing co-development activities.
3. Neither company had a comprehensive map of their design processes.
4. Neither company had a performance measurement system (beyond the time and cost of construction) that could be used to indicate the key drivers of their business and where changes were impacting on performance.

Major benefits were identified with one of the companies by focusing upon their process mapping requirements - locating when and what information needed to be made available (and with what degree of certainty). This resulted in a saving of many weeks in their total design and construction process.

Lean Production and Lean Design

The majority of the current change/improvement tools being used within construction have been developed from the automotive sector, with *lean production* being seen as a key route to success. *Lean production* has become synonymous with better, cheaper and faster in automotive, but as lean production skills have been honed and waste driven out of the production process, so other tools have become needed for automotive companies to retain their competitive edge. The Cogent programme illustrated how the development of *lean design* could bring about a step change in performance by a company, already acknowledged as an expert in *lean production*, as

they devolved design authority for the majority of a vehicle's sub assemblies to a small group of high performing suppliers[4].

Within construction the focus of most of the *improvement* activity focus has been upon raising the performance at site level, with lean production tools attracting the most interest as the way to bring about sustained improvement.

Hines (1994) has defined the methodology behind lean production, noting crucially that it is a joint activity.

> "The logic of lean production is that companies jointly identify the value stream for each product from concept to consumption and optimise the value stream regardless of traditional functional or corporate boundaries".

Kanter (1994) describes collaboration as,

> "a company's competitive advantage. In the global economy, a well-developed ability to create and sustain fruitful collaborations gives companies a significant, competitive leg up".

She goes on to define collaboration as

> "creating new value together rather than mere exchange, getting something back for what you put in".

Partnership and Partnering

The word most often used to suggest that a revised method of working is in place in construction has been "partnership", and by re-branding the contractual relationship there has been the expectation that the way people work and the attitudes and values they bring to a situation will be fundamentally changed. However there is as yet no single, agreed definition of partnership and subsequently the term has been over-used and often abused.

Burnes and New (1996) found that

> "the term partnership was used in a wide variety of ways, often with ironic undertones…the term partnership has become devalued through over use and abuse and as a result is difficult to define and execute".

One service contractor partnering with a major utility expressed the view to one of the authors that partnering agreements actually impeded performance improvement. If he exceeded a key performance indicator (KPI) by more than 10% triggered a mechanism was triggered that questioned his costing process for emergency work which by its very nature was full of uncertainty.

The Japanese however viewed their suppliers as critical to their own success and so developed an approach that reflected their inter-dependence.

> "The contrast between the Japanese model of subcontracting and that which, until the mid 1980's at least, pertained in the West, can be summed up as a contrast between 'obligational' contracting in the former and 'adversarial' contracting in the latter"
>
> (Morris and Imrie 1993).

[4] Within the automotive sector the key Tier 1 suppliers have graduated within the supply chain to systems integrators, responsible for development, design, manufacture, and in some plants on line assembly.

> "Obligational contracting…implies that the firms involved recognise their inter-dependence and the importance of maintaining an ongoing relationship for future business"
>
> (Ellram 1991)

Winch (1996) contends that the professional system fragments the design and construction process and inhibits the ability of suppliers to participate in co-development activity.

The Move to Co-Development

The Cogent programme on co-development was being delivered at exactly the time that the Construction Task Force (1998), working on "Rethinking Construction" under the guidance of Sir John Egan were visiting Nissan's manufacturing plant in Sunderland to see what ideas could be utilised from automotive. Paragraph 59 stated,

> "Suppliers and subcontractors have to be fully involved in the design team".

Co-development within automotive has meant the agreement to engage suppliers at the design stage, agreeing target prices and working together through design to ensure that components and assemblies can be made at the highest quality for the lowest **total** cost. "Total" here may mean a more expensive tool, resulting in lower warranty claims in the future, or a superior performance material offering weight savings. Co-development means two organizations working together, sharing data, agreeing costs and collaborating to drive cost out and quality up. The design supplier expects the manufacturing order, and savings beyond the target cost are shared, but in return accepts the responsibility of generating innovative ways to continually improve.

The construction industry has many years of experience of drafting contracts and specifications, and to date a lot of energy for improvement has gone into devising new contractual methods of working. Rethinking Construction (1998) mentioned in paragraph 69 the lack of formal contract between the within the automotive sector beyond an annual cost and quality negotiation, which were expected to result in higher quality for less cost (but not less percentage profit) the following year. This difference in approach to relationship management may explain some of the difference in performance between the two sectors.

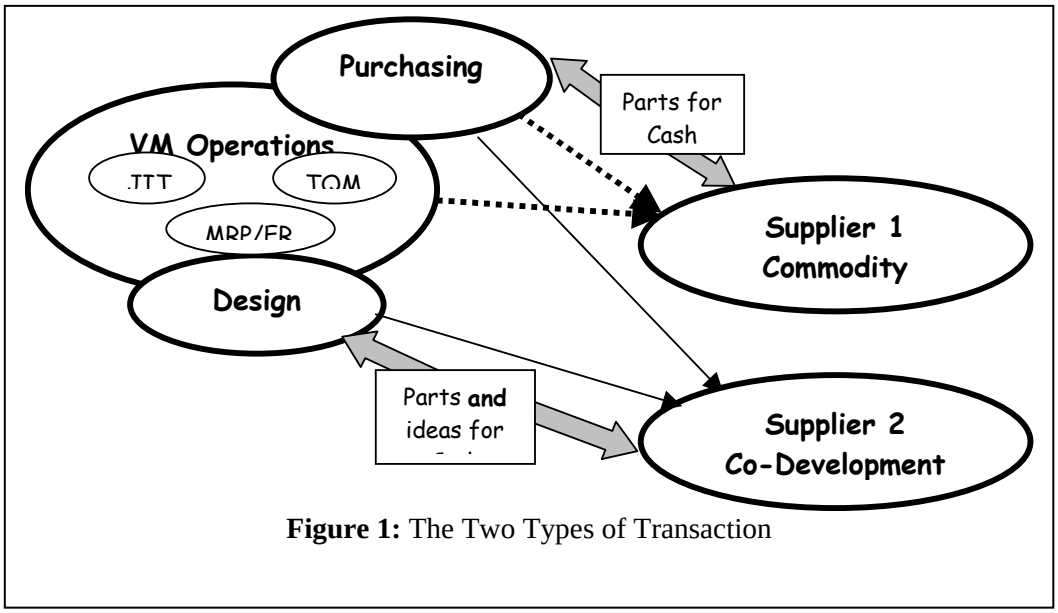

Figure 1: The Two Types of Transaction

Figure 1 is a schematic drawing illustrating the different types of transaction that can occur in automotive. For commodity supply (within construction this would be bricks, cement, etc), and where purchasing can procure against a standard a simple, competitive tendering contract (Parts for Cash) can be used foe supplier 1. However when supplier 2 is invited to join the design process, there is an instantaneous problem created of how can a specification for supply (Parts **&** Ideas for Cash) be offered when the design has not yet being fixed? Supplier 2 also has a problem of judging how to offer really good ideas to reduce cost and time and enhance quality and buildability if there is no mechanism in place to rewards this effort, (and maybe not even guarantee receipt of the work)? Rethinking Construction (1998) recognised this difficulty in para 70, stating that it is *"potentially difficult...to set up long term partnering arrangements"*.

Automotive has embraced this problem, by establishing long term relationships with suppliers who have full design responsibility **and** activity develop new products, processes and ideas to ensure that they add value to their customers' product. This long term commitment would not be sustainable if when problems arose the parties reached for the contract documents to see what their expected liability may be. The absence of a formal contract focuses effort by all parties upon problem solving rather than situation exploitation.

CONCLUSIONS

The Cogent programme demonstrated that a world expert in lean production could further develop the philosophy into lean design, and achieved a step change in performance from investing the time and resources into a major change programme. The initial work taking this knowledge across into construction has demonstrated that there are big gains to be made from adopting some of the best practice tools from automotive. The pilot programme work indicated that there is a two-stage model:-

1. The need to internally align organizations and develop their internal processes
2. Co-development design activity between Prime and key sub-contractors.

Both activities require a major commitment to generate returns significantly above those currently enjoyed in construction, and in the past by automotive.

Construction improvement efforts post-Egan have predominantly focused upon post-design activity, and although there is a desire amongst both contractors and suppliers to change the way construction operates, the performance improvement leap has not yet materialized - reports still quoting 10% per annum target improvement, (Egan, 2002) being achievable, when M4I results in the same report for 2001 detail a 4% enhancement in cost. The introduction of key suppliers into the design loop is crucial to improving construction's performance to a level that is acknowledged to be available when a team approach is pursued all the way from design to delivery, and onward through use. There are many excellent texts on partnership in construction, (Bennett and Sarah Jayes 1995, 1998, CIB 1999) but little evidence yet that the construction is prepared to invest the time needed to adequately implement change. The tools and techniques are available for use, but as noted by Winch (1996) contractual relationships and procurement processes may be hindering progress.

The Cogent programme required over 8 man-years of time for Nissan, and 11 man-years of researcher time, including two years at professorial level. This figure excluded the time that Nissan staff and the 100+ suppliers' employees spent in workshops. The Cogent Programme achieved the targets set, reducing the design time by 30% and design cost by 40%. The target of 30% reduction in manufactured part cost was exceeded. Internal cost measurement systems recorded total cost and time taken in the design process, the reduction in manufactured cost included supplier cost and those internal costs associated with final assembly into a vehicle. These included such items as reduced time to assemble, lower transportation costs to suppliers (passed on to VM), reduction in warranty costs, etc.. Within the programme in excess of one VM man-year was expended in root cause analysis of problems requiring a design change, a feature known to have major cost implications, rising exponentially towards the date of production. This resulted in 80% less design changes, repeated in the next design cycle, resulting in a 96% reduction in design changes over two design cycles. The process is on-going.

Cogent contributed to a 2,400 man-months reduction of vehicle design time.
For an expert in lean to improve in this manner, whilst raising reliability and performance at the same time, having lived lean production for over a decade does at least give construction hope that one day the target improvement figures suggested by Sir John Egan *et al.* may be achieved. The improvement tools developed within Cogent have been shown to have applicability in construction and to generate major time, and cost savings, both in design and the actual component manufacturing stage. However this limited amount of work suggests that construction will need to invest large amounts of time on internal activities before the future anticipated benefits of co-development can be garnered.

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