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This research project, funded under the Australian Research Council SPIRT program, is investigating the links between organisational learning and performance. It is exploring the management of innovation, the implementation of improvements and the interface between systems, processes and technology in automotive components manufacturing. We are attempting to identify sources of knowledge available to manufacturers and to explore processes by which employees, suppliers and customers contribute to, and benefit from, internal process improvements. The links between organisational learning and performance are being examined over two years through a combination of qualitative and quantitative research into the processes and management of improvement activities. The project is building on previous international research, developed for Australia. While Australian manufacturers share important characteristics with those of the UK and USA as part of the global automotive industry, it is expected that local economic and institutional features will inform important variations in practice and form.

This paper describes the methodology being used, outlines our progress to date and presents a summary of our interim findings.

With only a comparatively small domestic market, the survival and growth of manufacturing organizations in Australia depends on safeguarding their share of the domestic market and gaining a competitive position in the international market. Competitive pressures and shareholder expectations are forcing Australian organizations to do more with less. In response to fierce international competition, Australian academics and practitioners alike are trying to identify how organizations can achieve ‘world class’ standards of production. Much of the research published in this area during the 1980’s and 1990’s has concentrated on the phenomenal growth of the manufacturing sector in Japan in the post world war II era (Adler & Cole, 1993; Stainer, 1995; Womack & Jones, 1990). Japanese manufacturing organisations have in many cases, managed to outperform Western organisations, not just on the international market but also in their own backyards (Delbridge, Lowe, & Oliver, 1995; Oliver, Delbridge, Jones, & Lowe, 1994; Oliver, Delbridge, & Lowe, 1996a; Womack & Jones, 1990; Womack & Jones, 1996b).

Even the critics of lean production (Cusumano, 1994; Williams et al., 1992) generally agree that Japanese manufacturing plants are amongst the best in the world in terms of productivity and quality (although they argue that this is just a temporary state until North America’s aging manufacturing infrastructure is replaced or recession in Japan removes Japan’s unfair advantages). So what are the production methods used by ‘world class’ Japanese organisations?

In ‘The Machine that Changed the World’ Womack and Jones (1990) describe the Japanese production system (termed ‘lean
production’) which is proclaimed as the foundation of the Japanese success stories. Although elements of ‘lean production’ vary from study to study, most tend to agree on the six elements below:

1. Devolution of responsibility to frontline workers,
2. Organisation into work teams,
3. Employee involvement in continuous improvement,
4. The use of visual factory flows,
5. Just-in-time to eliminate in-process buffers and eliminate waste, and
6. Close, shared destiny relations with suppliers.

The learning factory concept has developed as competition emphasised the need for continual improvement of products, processes and performance (Hamel & Prahalad, 1994; Kochan, Lansbury, & MacDuffie, 1997). Having innovation as its central motif, a learning factory generates, codifies and applies knowledge to improve its products and technologies (Nonaka & Takeuchi, 1995). Continuous improvement is achieved through problem-solving knowledge workers for whom the expenditure of ‘mental’ as well as manual labour is central to their role (Kenney & Florida, 1993). Improvements are sought from external sources (Kaufman, Merenda, & Wood, 1996) and the organisation is embedded in an innovation network of collaborators with whom there is information exchange and shared learning (Powell, Koput, & Smith-Doerr, 1996).

One of the central components of the learning factory is the need for multi-skilled and flexible workers operating in a team to identify and solve problems swiftly. Employees are now expected think, to learn, exercise judgement, act independently where necessary, and work collaboratively with teammates. The question is how much an organisation can expect from employees for their labour dollar, particularly if those employees have in the past been treated as mindless drones or ‘passive cogs’ in the production machine (Aktouf, 1992), and what the conditions are within an organisation or a work group that will encourage employees to get involved and speak up in order to improve performance.

Building on the work of a group of researchers based in the UK, the learning factory project attempts systematically to research links between organisational learning and manufacturing performance in the Australian automotive components manufacturing industry. The links are being investigated by examining how learning structures and processes, specifically continuous improvement and problem solving activities, impact on productivity and performance in different organisations.

Previous Research
In collaboration with Dr. Rick Delbridge of Cardiff University and Dr. Nick Oliver of Cambridge University, this project provides an opportunity for organisations within the Australian automotive components manufacturing industry to participate in an international benchmarking study. Comparable data is being collected in the UK, USA, and Japan by a team of researchers from the Cardiff Business School and Cambridge University.

The current project has evolved from studies undertaken by Delbridge & Oliver over a ten-year period, as described below.

The Lean Enterprise Benchmarking Study
In 1991, Delbridge and Oliver were members of a team that conducted a systematic benchmarking project of a matched sample of UK and Japanese automotive component suppliers. The study was designed to test the relationship of lean production with performance proposed by the International Motor Vehicle Program. The findings were widely reported in the press, and publicized through a series of presentations to industry and published in academic journals (Delbridge, 1995; Oliver et al., 1994).

The Worldwide Manufacturing Competitiveness Study
The success of the above project spawned a second, larger study, which was completed in 1994. It involved research in nine countries across Europe, North America and Asia. In
total, 71 auto component suppliers were benchmarked, 13 of which achieved world class productivity and quality performance. The top performing plants demonstrated high levels of internal process discipline and control, consistent with the lean production model. Andersen Consulting published 30,000 copies of the report, the findings received press coverage internationally and presentations of the findings were made in several countries. This research made a significant contribution to academic debates over best practice and performance and the findings have been disseminated through leading academic journals (Lowe, Delbridge, & Oliver, 1997; Oliver et al., 1996a; Oliver, Delbridge, & Lowe, 1996b).

High Performance Manufacturing and the Learning Factory
This is a UK government research council project to examine the links between problem-solving, continuous improvement and manufacturing performance (EPSRC, grant no. GR/L93591). One of the objectives is to develop models of best practice for learning in a manufacturing environment. The research is an extension of previous work and will benchmark performance in samples of UK, USA and Japanese automotive components manufacturers.

Methodology
This project requires a combination of research approaches to examine both 'espoused theories' and 'theories-in-use' (Argyris, Putnam, & McLain Smith, 1985) within the organisations. The methodology includes a robust quantitative analysis of performance and of problem-solving and improvement activities. This analysis is then being complemented with qualitative data collection to allow richer examination of the processes that affect knowledge acquisition, development and dissemination.

Phase 1
From the literature, and drawing on the prior studies mentioned, items have been developed for assessing management practices, manufacturing performance and benchmark change over time (1994 and 1999) as learning organisations in the automotive industry. This has required identification of measurable items which bear directly on management practices and manufacturing performance, and which reflect elements of knowledge acquisition, development and dissemination within organisations.

During Visit 1 to participating companies, the project is fully explained, the survey instrument presented to a nominated coordinator, any questions or concerns addressed and then agreement negotiated for a return visit. This is followed by an interview to obtain a broad overview of how problem solving and continuous improvement is managed within the company. The instrument is then collected by the researchers on Visit 2 four to eight weeks later, when all responses are double-checked with participants. This process is essential for gathering the most comparable and trustworthy data possible.

Phase 2
This phase incorporates Visit 2 by two researchers at a time to each of the companies for approximately two days in each (80 researcher-days) to undertake intensive qualitative study. They will explore systems and processes that affect knowledge acquisition, development and dissemination. Our methods in this phase will include in-depth interviews with selected production workers, supervisors and managers (taped if agreed to by interviewees, or otherwise noted), observations and shadowing, and content analysis of relevant company documents/records.

Phase 3
Phase 3 will involve construction of models of best practice in knowledge acquisition, development and dissemination within automotive components manufacturing, and development of guidelines for implementation. It will involve creative work in synthesising the findings obtained from Phases 1 and 2 and drawing from the literature studied earlier. This phase will also include the production of a self-assessment tool based on the instrument developed and used in Phases 1 and 2,
together with items that emerge during the study as particularly relevant to performance as a learning organisation.

Results to Date

Although the Australian and Japanese components of this study are yet to be completed, data collection in the UK and USA has been completed. Initial analysis of the quantitative data has yielded some interesting though not totally unexpected results.

The data in Table 1 show quite clearly that both UK and US companies have adopted teamworking as an important organisational concept (89% and 100%) and have organised their shop floor operators into teams (88% and 99%). These companies also place high importance on these teams' involvement in problem solving activities. The adoption or use of suggestion schemes is rather interesting with the US reporting a much higher adoption rate. It could be that UK companies have found that problem-solving activities may be reducing the need for suggestion schemes. This issue needs further clarification.

Table 1

<table>
<thead>
<tr>
<th>SHOPFLOOR ACTIVITIES</th>
<th>US</th>
<th>UK</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team working</td>
<td>89%</td>
<td>100%</td>
<td>94%</td>
</tr>
<tr>
<td>% Operators in teams</td>
<td>88%</td>
<td>99%</td>
<td>94%</td>
</tr>
<tr>
<td>Teams hold problem solving meetings</td>
<td>75%</td>
<td>33%</td>
<td>53%</td>
</tr>
<tr>
<td>Suggestion scheme</td>
<td>78%</td>
<td>55%</td>
<td>67%</td>
</tr>
</tbody>
</table>

(Delbridge, 2000b p 7)

Table 2

<table>
<thead>
<tr>
<th>Long term, routine groups</th>
<th>US</th>
<th>UK</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave % of operators involved</td>
<td>52%</td>
<td>70%</td>
<td>58%</td>
</tr>
<tr>
<td>Management determines activities</td>
<td>29%</td>
<td>17%</td>
<td>23%</td>
</tr>
<tr>
<td>Group determines activities</td>
<td>29%</td>
<td>33%</td>
<td>31%</td>
</tr>
<tr>
<td>Activities jointly determined</td>
<td>43%</td>
<td>50%</td>
<td>46%</td>
</tr>
<tr>
<td>Cross functional membership</td>
<td>57%</td>
<td>83%</td>
<td>69%</td>
</tr>
</tbody>
</table>

(Delbridge, 2000b, p 8)

Table 3

<table>
<thead>
<tr>
<th>SPECIALIST ROLES</th>
<th>US</th>
<th>UK</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel with direct responsibility for management of shop floor problem solving</td>
<td>89%</td>
<td>100%</td>
<td>94%</td>
</tr>
<tr>
<td>Responsibility dispersed</td>
<td>88%</td>
<td>0%</td>
<td>44%</td>
</tr>
<tr>
<td>Responsibility focused on key individuals</td>
<td>12%</td>
<td>100%</td>
<td>56%</td>
</tr>
<tr>
<td>Personnel with direct responsibility for management of continuous improvement</td>
<td>89%</td>
<td>100%</td>
<td>94%</td>
</tr>
<tr>
<td>Responsibility dispersed</td>
<td>63%</td>
<td>0%</td>
<td>31%</td>
</tr>
<tr>
<td>Responsibility focused on key individuals</td>
<td>38%</td>
<td>100%</td>
<td>69%</td>
</tr>
</tbody>
</table>

(Delbridge, 2000b, p. 10)
Separate results also show what one would expect to find in most automotive manufacturing and what are commonly referred to as quality circles, referred to in our later discussion as planned step improvement. These groups are short term (US 100% and UK 88%), have cross functional membership (US and UK both 100%), lower percentage of shop floor operators involved (US 14% and UK 35%) and management determining the problem to be solved (US 67% and UK 50%). Table 3 indicates a marked difference between the two countries with respect to the role of specialists. UK companies report 100% adoption of specialists with direct responsibility for management of shop floor problem solving, responsibility for problemsolving focused on key individuals, personnel with direct responsibility for management of continuous improvement and responsibility focused for continuous improvement on key individuals. In contrast, within the US companies, responsibility for management of shop floor problem solving is more dispersed (US 88% and UK 0%) and as is also responsibility for management of continuous improvement (US 63% and UK 0%).

Table 4 shows that both countries have adopted similar strategies for inter-organisational links. They have regular corporate review visits, benchmark within their own group, share design of components and joint cost reduction activities with their suppliers and customers.

**Discussion**

Our UK research collaborators have found that the participating companies have adopted three types of problem solving and continuous improvement activities. They are:

- Planned step improvement
- Proactive incremental improvement
- Reactive improvement

The characteristics of each types of problem-solving and continuous improvement activities are summarized in Table 5.

What these interim findings indicate is that approaches to problem-solving and continuous improvement are:

- Moving from reactive to proactive

### Table 5

<table>
<thead>
<tr>
<th>Problem-Solving and Continuous Improvement Activities</th>
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<tbody>
<tr>
<td><strong>PLANNED STEP IMPROVEMENT</strong></td>
<td><strong>PROACTIVE INCREMENTAL IMPROVEMENT</strong></td>
</tr>
<tr>
<td>• top down direction,</td>
<td>• participation,</td>
</tr>
<tr>
<td>• targeted specific short term projects,</td>
<td>• long term routinized activity,</td>
</tr>
<tr>
<td>• cross functional-management prime actors,</td>
<td>• individual and/or collective-shop floor prime actors,</td>
</tr>
<tr>
<td>• plant-wide focus,</td>
<td>• shop floor focus,</td>
</tr>
<tr>
<td>• significant impact on key operating measurables, and</td>
<td>• series of small impacts on operating systems and improvements broadly defined</td>
</tr>
<tr>
<td>• cost saving as the underlying rationale</td>
<td></td>
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</table>
LEARNING TOGETHER, WORKING TOGETHER IN THE "LEARNING FACTORY"

- from ad hoc to specialists to diffused responsibility
- increasingly becoming standardized routines
- increasing the breadth of participation
- moving from 'practices' to 'systems'.

It remains to be seen whether these findings will be replicated in the Australian research. If they are, there will be considerable implications for the nature and organization of work, particularly at shop floor level, and in respect of the skills and training required to equip labour for these expanded roles within contemporary manufacturing.

References


Delbridge, R 2000a, Continuous improvement through supply chain management. Unpublished Power Point Presentation, Cardiff University.


