Table 1: OL Conceptual framework for PI/CI

| Concept | Contributing Literature |
|---|---|
| **Individual behavior**: Individuals identifying new ways of solving organizational issues (generating ideas) | March (1991), Argyris and Schon (1992), Crossan et al. (1999), Jorgensen et al. (2003) |
| **Group discussions:** Group activities focused upon identifying and questioning individually held assumptions (creating knowledge) | Nonaka and Takeuchi (1995),Crossan et al. (1999), Lee et al. (2000), Jorgensen et al. (2003) |
| **Organizational processes:** Organizational policies, culture and strategies that focus upon long-term development (learning resources) | Fiol and Lyles (1985), Levitt and March (1988), Bessant and Francis (1999), Crossan et al. (1999) |
| **Policy development:** Feed forward ideas from individual and group activities into organization-level processes (capturing insight) | Fiol and Lyles (1985), Francis and Bessant (1999), Crossan et al. (1999) |
| **Policy use:** Feedback organizational resources, strategies and procedures to inform individual and group-level behavior (translating insight into action) | Fiol and Lyles (1985), Crossan et al. (1999), Jorgensen et al. (2008) |

Table 2: Case Firms Summary

| **Company Name** | **Employees** | **Industry** | **Market** | **No. of Interviews** | **Position Held** | **Total time** | **Additional Data Sources** |
|---|---|---|---|---|---|---|---|
| Engineering Manufacturer 1 (ENG1) | 23 | Sheet Metal | Various | 4 | Managing Director (MD, General Manager (GM), Project Engineer (PE) | 5h | Website, site tour, follow up interview, company presentations |
| Engineering Manufacturer 2 (ENG2) | 10 | Compression Plastics | Oil/ Gas/ Various | 2 | Managing Director (MD) | 3h | Website, initial meeting, site tour, informal follow up meeting |
| Injection Moulding 1 (INJECT1) | 73 | Injection Moulding | Automotive/ Various | 4 | Production manager (PDM), Project Manager (PM), Assistant Operations Manager (AOM) | 5h30m | Website, site tour, follow up meeting, customer meetings |
| Injection Moulding 2 (INJECT2) | 35 | Injection Moulding | Double glazing/ Various | 3 | Managing Director (MD), Project Manager (PM) and Production Manager(PRM) | 6h | Website, follow up interview, social media updates |
| Systems Integrator (SYSINT) | 25 | Advanced Manufacturing Equipment | Manufacturing Companies | 3 | Engineering Directors (ED), Operations Director (OD) and Project Engineer (PE) | 7h40m | Website, site tour, partner websites |
| Building Contractor (BUILD) | 49 | Construction | Residential/ Care homes/ Industrial/ Various | 4 | Managing Director (MD), Quality Consultant (QC), Operations manager (OM), 2 x Project Managers (PM) | 9h | Website, interviews with customer and supplier, site visits, site meetings, follow up meetings |
| Total | | | | 20 | | 36h10m | |

**Table 3: Chain of Evidence**

| **PI/CI Practices** | **Organisational Learning** | **Emergent Themes** |
|---|---|---|
| Operator Responsibilities | Individual Behaviours | Management support of individuals |
| Groupwork | Group Discussions | Management providing resources for PI |
| Formal Procedures | Organisational Processes | Management providing opportunities for PI |
| Management Support | Policy/Procedure Development | Individual perceptions of PI |
| Training | Policy/Procedure Use | Benefits realised from PI |

Table 4: ENG1 - Illustrative case evidence

| **Illustrative evidence** | **Interpretation** | **OL dimensions** |
|---|---|---|
| "*If it takes a group of you to get together before we found out we've got a problem, I'm sure the group will get together and work it out, and we'll find a solution*" (PE, ENG1) | Sharing knowledge and solving problems through group discussions | Individual behaviour, group discussions, policy development |
| "*while that first order was going through [PE] was redesigning the unit into component pieces… 'we've got it to you as quickly as we can'… 'for any new ones, we're offering this now'… we make samples and prototypes, [the customer] takes it away, builds it and says 'great, off you go'… we've had 3 orders off the back of that with the new design*" (MD, ENG1) | Proactively improving products to win repeat and new business | Individual behaviour, policy development, organisational process, policy deployment |
| "*We will get a new drawing, an issue will change, [production control will] change the [route] card and pass through to programming whatever necessary changes they need to make and the card's updated for next time*" (GM, ENG1) | Deliberately changing product designs and organisational processes | Individual behaviour, group discussions, policy development, organisational processes, policy deployment |
| "*steel was going up and we were frightened to go back to the customers ... 'we'll have to put our prices up', we made a policy that every time a job came through, we were going to re-evaluate it, and look at the products [to see what saving could be made], and I tell you what, that made a big difference*" (MD, ENG1) | Raw material costs initiating formalisation of individual developed PI activities | Individual behaviour, policy development, organisational processes |
| "*these guys have been at loggerheads, it's like they all wanted to prove to me, I kept saying that's not what I'm after, I know whose good at what, I want you to work as a team to produce the product*" (MD, ENG1) | Pursuit of individual goals affecting group behaviours | Individual behaviours, group discussions, policy deployment |
| *"If we can keep learning about their product, and making it better, and [the customer will] modify [their designs] slightly, they'll learn about us as well, and at the moment, they're working with us to improve [their product], which I wouldn't say it's guaranteeing the business, but it's going a long way to making sure we get it, and we can keep performing and showing them savings*" (GM, ENG1) | Working with customers to realise benefits and helping to win new business | Group discussions (inter-organisational), policy development, organisational processes |
| "*we've got quite a good level machinery… they're fairly new, fairly up to date, but also we're using some of the good old ideas...the idea is get a lot of good lads and pay them quite well… but we're bring them on [through training] at the same time*" (GM, ENG1) | Management investing in equipment and staff to support individuals to make improvements | Organisational processes, Policy deployment, individual behaviour |
| "*I've been involved with BSI for quite a while now, over these past two or three years they've come into the real world... it's that you're doing your management meeting minutes, or an informal discussion and it's actually more in line with being integral to your business rather than a bolt on... promoting CI*" (GM, ENG1) | Operating systems both being viewed by auditors and managers as part of how the business operate. | Organisational processes, individual behaviours, policy deployment |

Table 5: ENG2 - Illustrative case evidence

| **Illustrative evidence** | **Interpretation** | **OL dimensions** |
|---|---|---|
| "*the lads on the shop floor tend to [make improvements] as well… sometimes they don't even tell me, they just start doing it… it is very difficult getting people to interact"* (MD, ENG2) | PI being made by individuals in isolation and not integrated into procedures | Individual behaviour |
| "*you can spend weeks and weeks showing someone on the shop floor how to [use a new piece of equipment], and they get up and leave [the company], because you've given them an extra qualification, and they can now go and get a better job*" (MD, ENG2) | Individual training not linked to in company development or internal improvement activities | Individual behaviour |
| "*the bigger companies… have a [non-compliance report] certification, which usually has a part you have to fill in and send back, with reasons why/how this [problem] arose, what you're doing about it, what are you doing to stop it happening again, so it's corrective and preventative action… I like to see [the product]… see if there is any sort of link, any road you can go down, that tells you why it has happened*" (MD, ENG2) | Formal problem solving processes to demonstrate to customers changes have been made | Individual behaviours, policy development, organisational processes |
| "*at the moment, I don't go out and look for the new business because it comes to us in the way of an enquiry, or somebody rings up and says do you supply?*" (MD, ENG2) | Management not directing the type of business being acquired | Individual behaviour |
| "*I mean it's such a small [portion of non-conforming parts], at one time the ISO people used to insist we did a statistical graph and it was like a line running along on the bottom and it would be something like 0.08% rejects... miniscule sort of percentage, so it's … not even viable to record in any statistical way"* (MD, ENG2) | Operations systems effective at preventing returns from customers but fewer opportunities for improvement | Individual behaviour, organisational processes |
| "W*hy don't you just have it as a straight edge?... it would be a lot cheaper for you, it would be a lot easier for us to make, we'd be able to do it a lot quicker for you', things like that, for ease of manufacture point of view, occasionally their draftsmen, the people who do these drawings have not got much knowledge of production*" (MD, ENG2) | Involvement with customers helping identify improvement opportunities | Individual behaviour, policy development, group discussions (inter-organisational) |
| "*you get a bit too busy, people tend to skip things*" (MD, ENG2) | Procedures not always been followed by operators | Individual behaviour, organisational processes |
| "*you tend to, it sometimes takes me to not pick the best person for the job for the training, because you know he'll accept it better or he'll fit in better doing it, because he's got the dominance to do it and brush off any sarcasm or criticism" (MD, ENG2)* | Individual and group behaviours affecting the support management provide | Policy deployment, group discussions, individual behaviour |
| *"it's not telling them how to do the job, they already know how to do the job, it's telling them how to do the job and make sure they've checked everything they're doing*" (MD, ENG2) | Management instructing operators to follow inspection procedures | Organisational processes, policy deployment, individual behaviour |

Table 6: INJECT1 - Illustrative case evidence

| **Illustrative evidence** | **Interpretation** | **OL dimensions** |
|---|---|---|
| "*there is nothing down there in the first place, nothing to tell you where to find that information [can be found], place, there are no procedures… if you hit on a problem, you experience it, you obviously write it down for the next time*" (PM, INJECT1) | Individuals capturing their own learning rather than procedures | Individual behaviour |
| "*[individuals not accepting the need to change] is exactly what's happening in this business, and it's took years really, and even now, it's a total resistance to change, I mean we're forcing through the change, but even so, it's more difficult because they're resisting it*" (AOM, INJECT1). | Production resisting changes suggested internally and by consultants | Individual behaviour |
| "when you were sort of drafted into the moulding side, and they're not keen or friendly regarding the tools and things there, you realise very quickly that they haven't got it... it's like going back 20 years" (PM, INJECT1) | Production staff actively resisting external support for improvement | Individual behaviour |
| "*[A tier one automotive supplier] chose 5 of their suppliers… we are one of the 5 suppliers, because [they] probably choose bad suppliers, we need to improve quite a lot, [the consultants] came along to us and then we work on improvement activities*" (PDM, INJECT1) | Working with consultants to improve operational performance for a customer | Group discussions (inter-organisational) |
| "*If we wanted to go on say two visits to China, just to prove the tool, it would be so costly, you might as well have had the tool made in England*" (PM, INJECT1) | Management attention on short term, lower cost options | Organisational procedures |
| "*The business required ISO; the only thing was it's not really kept pace with the business… so you are reviewing it in times of desperation*" (PM, INJECT1) | Operational procedures not used to direct normal practice. | Organisational processes, policy deployment, Individual behaviours, |
| "*we've got our own [improvement initiative], that's key to the business… it's all about lean manufacturing basically… [production are] not even at that stage yet… they keep slipping back*" (AOM, INJECT1) | Internal improvement initiative not supported by production | Organisational procedures, policy deployment, individual behaviour |
| "*We're definitely overworked, that's a fact… we're asked to do unrealistic amounts of work, projects we have to get involved in, I mean [the quality manager] is off at the moment, we end up taking the slack" (AOM, INJECT1)* | Insufficient resources for improvement practitioners to implement and maintain changes to practice | Organisational processes, policy deployment, individual behaviours |
| "*We're looking for any business, [but] there is a fine line ... you can win business you can sometimes not really desire, but it's revenue… If you've been given a tool transfer, you've got age, quality issues, problems inherent in the tool design, because you don't know why it's actually been moved, it could be cost, it could be quality, could be other things, the customer is not really going to tell you*" (PM, INJECT1) | Business strategy focusing on increasing business introducing problems but not PI opportunities | Organisational procedures |

Table 7: INJECT2 - Illustrative case evidence

| **Illustrative evidence** | **Interpretation** | **OL dimensions** |
|---|---|---|
| "*it's okay for us to put plastic in a machine and squirt it and fill a mould tool but we've got to absolutely ensure that that is absolutely bang on the nail. And all the staff have to be responsible for that, and not able to just walk past and take no notice*" (MD, INJECT2) | Consistent use of procedures with operators focused on identifying any deviation | Individual behaviour, policy deployment, organisational processes |
| "*it was very satisfying for us but also for [the customer], it resolved a massive problem that he came to a small company, we were that full package, we could look at the design of the mould tool… raw materials… And that produced a first-class product*" (MD, INJECT2) | Multiples skills and capabilities to solve complex customer problems | Individual behaviour, group discussions, organisational behaviour |
| "*The best solution I find to resolving production problems is to involve everybody. And I said it recently to our stores department, 'I am not going to dictate to you how you should run the stores department.' I'll put some corn down for you and you pick up and run with it… And the beauty of that is then of course if you have that discussion, everybody's bought into it. You're not dictating to somebody because you know, we all made the decision collectively. I think generally… well it's not perfect, of course it's not, generally it works"* (MD, INJECT2) | Management supporting operators in solving their own operational issues, drawing from individual knowledge developed through group discussions to promote acceptance of new approaches to working | Individual behaviour, group discussions, policy development, organisational processes, policy deployment |
| "*when somebody comes back to you with a mould and says 'Look what's happened', it jumps out at you what's happened.*" (MD, INJECT2) | Individual knowledge to identify improvement opportunities and solutions | Individual behaviour |
| "*Because ultimately, we all want a wage increase it's as simple as that. And the only way we get that is by making more profit and the only way there's going to be more profit is to be more efficient.*" (MD, INJECT2) | Management justifying the need for PI in terms of increasing wages | Organisational processes, policy deployment, individual behaviour |
| "*No matter how innocent you think that request [to change tooling] is, that has to go through the procedure*" (MD, INJECT2) | Consistent use of, and change to, procedures to ensure appropriate outcomes of process changes | Organisational processes, policy deployment, individual behaviour |

Table 8: SYSINT - Illustrative case evidence

| **Illustrative evidence** | **Interpretation** | **OL dimensions** |
|---|---|---|
| *"that's probably where we're a little bit weak because we've relied on experience and quality of individuals rather than processes"* (OD, SYSINT) | Procedures not relied upon to direct individual behaviour | Individual behaviour |
| *"It's very rare that [the Directors] make [significant errors and]… have to do significant rework, but we don't get the same out of our employees… And to me it's an attitude issue rather than a clear training issue"* (ED, SYSINT) | Individual experience and approaches determining the standard of work produced | Individual behaviour |
| "*So at the moment we're just trying to get… a group together and work out how we can review our software design process. It's one of those things that over the past 10/20 years has always been done in the same way*" (OD, SYSINT) | Trying to change long embedded individual behaviour through group activities | Individual behaviour, group discussions |
| "*So [operator's attitude] creates an atmosphere in an office that prevents people sharing. Me telling you a story, [then someone] will butt in and so suddenly [the engineers'] office can be very quiet and yet [the Directors'] office can be full of banter and laughter… it can be affected by just whether or not one person's in the office"* (PE, SYSINT) | Individual attitudes affecting the willingness to engage in open discussions. | Individual behaviour, group discussions |
| "*as soon as the housing market crashed and nobody was building houses, the aggregate business has plummeted… bars of chocolate has gone through the roof, can't do enough. People eat… in depression they eat chocolate and smoke cigarettes and guess who our two biggest customers are?*" (PE, SYSINT) | Business growth determined by sector growth, reducing the motivation for PI | Individual behaviours, Organisational processes |
| *"I suppose one of the challenges that we have is we do tend to find that projects are already identified, budgets are already planned and then we're bidding on the basis of cost"* (ED, SYSINT) | Limited opportunities to develop acquired work | Individual behaviour |
| *"they're actively pairing people up in projects to try and start making this merge happen but there's definitely a two culture existence*" (PE, SYSINT) | Managers taking steps to change how individuals approach their work | Group discussions, policy deployment, individual behaviour |
| *"You kind of recognise the value of having a good quality management system behind you to back up whatever stories you want to tell [the client]" (PE, SYSINT)* | Operational procedures supporting interactions with customers | Organisational processes, policy deployment, group discussions (inter-organisational) |
| *"[management are] realizing that they must make the new people work to procedures for them to have a successful business… I think they've gone through a real pain barrier of wanting freedom and at the same time recognising that they've got to have structure"* (PE, SYSINT) | Managers changing their view of the role of procedures | Organisational processes, policy deployment, individual behaviour |
| "*we are ISO9000 registered for panel building; we're not registered for software, we're not registered for systems and solutions."* (ED, SYSINT) | Quality management systems not integrated to the processes that cause the most issues | Organisational processes |

Table 9: BUILD - Illustrative case evidence

| **Illustrative evidence** | **Interpretation** | **OL dimensions** |
|---|---|---|
| *"all staff know each other, we talk, so if somebody comes up with an innovative idea, you know, 'well he did this', 'but he did that', 'oh that's right', well we have project manager forums a couple of times a year where we all sit around the table together and discuss processes, better ways of doing things... We are all for change, about questioning tradition, think outside the box, why are you doing this, well we've always done it like that, well why?*" (PM2, BUILD) | Individuals willing to question existing perceptions on problems through discussions with other organisational members | Individual behaviour, group discussions, policy development, organisational processes |
| "*If you can keep so called firefighting down to an absolute minimum, then the more that you forward plan, the less fires you have to put out in the future… keeping the existing customers satisfied, so that you can hopefully get the next job with that customer*" (MD, BUILD) | Procedures to minimize predictable errors without being the focus of managers, allowing managers to focus attention on less predictable issues | Individual behaviour, policy deployment, organisational processes, policy development |
| "*We're looking to be more effective on site by controlling [systems], it's a balancing act, keep the paper work down to spend more time on site*" (PM1, BUILD) | | |
| "*all the staff that worked on those jobs have [gone] off around the industry somewhere else, possibly, invariably that's what does happen so all of the knowledge and skill of those jobs had gone*" (MD, BUILD) | Procedures as a means of capturing learning from individual projects to be applied on future projects | Individual behaviour, policy development, organisational processes, policy deployment |
| "*when we took the mechanical and electrical [subcontractors] up to their plant, [the] manufacturer was there, well they decided amongst themselves… talked about and drew up [their solution] on the drawing and that would have massively improved the time to connect the units on site*" (MD, BUILD) | Group discussion resulting in updated procedures and the reduction of errors on site | Group discussions, policy development, organisational processes, policy deployment, individual behaviour |
| *"this guy at [one location] was very, very helpful, and talked us through all the processes, 'this can shift if you do this', and he helped you to value-engineer the job… and because of that we're using him on several jobs now" (PM2, BUILD)* | Suppliers providing knowledge on what they provide that support the adaptation of internal processes | Group discussions (inter-organisational), policy development, organisational processes |
| *"when we're handing buildings over, there are generally less issues than there were 12 to 18 months ago… we go and talk to the client after the job has finished and gain their thoughts on the job, that is part of the ISO and the way that we've written up the system"* (MD, BUILD) | Systems to direct interactions with customers to enable further improvement and prevent problems recurring | Group discussions (inter-organisational), policy development, organisational processes, policy deployment |
| "*we're pushing hard [in one sector], they're active at the moment with this [economic] climate, hotels are still active, we're pushing in that [direction], we've got two tenders in at the moment and we're looking at who is actually spending money*" (MD, BUILD) | Management actively pursuing a range of business opportunities that introduce opportunities for PI | Organisational processes |

Table 10: Similar PI activities across the sample of companies

| |
|---|
| **Acknowledging customer complaints**<br>• Eng 1 - Formal internal procedures for receiving customer feedback<br>• Eng 2 - Internal and customer procedures for receiving and recording issues<br>• Inject 1 - Customers and internal procedures for receiving customer complaints<br>• Inject 2 - Formal internal procedures for receiving customer complaints<br>• Sysint - Problems are identified and noted during implementation in customer's facility<br>• Build - Customer meetings to discuss issues during and after projects |
| **Informing personnel and operators involved in the process**<br>• Eng 1 - Shares customer issues with operators<br>• Eng 2 - Notifies operators responsible for non-conforming parts returned from customers<br>• Inject 1 - Shares revised inspection procedures with relevant operators<br>• Inject 2 - Shares issues raised by customers with supervisors and operators<br>• Sysint - Engineers are required to rework non-conforming software<br>• Build - Non-conformance issues are shared across projects and with relevant operators |
| **Audit processes to ensure adherence**<br>• Eng 1 - Audited control of route cards to ensure use of correct versions<br>• Eng 2 - QMS systems audited and direct observations made of operator practice<br>• Inject 1 - Inspection of operator practice by improvement staff and customers<br>• Inject 2 - Formal auditing of QMS combined with auditing of operator practice<br>• Sysint - Panel building procedures audited as part of QMS, software writing outside QMS<br>• Build - Formal auditing conducted of procedure use and on-site practices |
| **Sharing solutions with customers**<br>• Eng 1 - Return of corrective actions to customers<br>• Eng 2 - Completion of customer correction and preventative actions documents<br>• Inject 1 - Return of customer specified corrective action documents<br>• Inject 2- Sharing of internal corrective actions with customer<br>• Sysint - Operation of projects verified with customers before sign-off<br>• Build - Formal meetings with customers to share issues and solutions on completion of projects |

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| | **Appendix 2a**<br>**Evidence from the more effective improvers** |
| **How** | **Groups developing new procedures**<br>• Eng 1 – specific evidence of the output of group discussions resulting in new procedures being developed<br>• Inject 2 – specific evidence of solutions being developed and captured in new procedures<br>• Build – specific evidence of project manager and supplier meetings resulting in developed and new procedures |
| | **Dedicated improvement practitioners**<br>• Eng 1 – specific evidence of a project engineer responsible for coordinating improvements and developing new products<br>• Inject 2 – specific evidence of a project manager responsible for introducing new business<br>• Build – specific evidence of consultant employed to introduce new operational procedures |
| **Support and Engagement** | **Engage staff and operators to develop solutions**<br>• Eng 1 – specific evidence of operators proposing changes to processes and procedures<br>• Inject 2 – specific evidence of operational staff given responsibility to develop solutions to recurring operational problems<br>• Build - specific evidence of working with different trades to develop new practices and inspection procedures |
| | **Utilise groups to share process knowledge**<br>• Eng 1 - specific evidence of group discussions to utilise process knowledge of operational staff to develop solutions<br>• Inject 2- specific evidence of supervisors and operational staff forming cross functional groups to discuss and develop solution<br>• Build - specific evidence of project managers, customers and suppliers discussing problems in regular project meetings to develop solutions |
| | **New business introduced that requires internal developments**<br>• Eng 1 – specific evidence of the requirement for new machinery and processes to manufacture new business<br>• Inject 2 – specific evidence of actively introducing new processes to be able to satisfy additional customer requirements and win new business<br>• Build – specific evidence of implementing a third party accredited QMS to meet requirements of public sector customers |
| | **Involvement with customer supported product development**<br>• Eng 1 – specific evidence of working on the development of existing and new product designs with customers<br>• Inject 2 – specific evidence of early stage product development work with customers to match product designs with process requirements<br>• Build – specific evidence of redesigning customer solutions based on process knowledge and further developing designs with customers |

| | |
|---|---|
| | **New equipment and suppliers proactively involved in product development**<br>• Eng 1 – specific evidence of working with equipment suppliers to learn process capabilities to apply to product development<br>• Inject 2 – specific evidence of working with materials and equipment suppliers in order to apply learning to product development<br>• Build – specific evidence of on-site involvement with suppliers leading to changes in product design |
| **Benefits** | **Benefits Realised from process improvement**<br>• Eng 1 - specific evidence of operational cost reductions helping to address the problem of increased material costs and win back previously lost business. Development of product designs to account for process requirements supporting the reduction of cost and improvement of functionality while maintaining profitability of work, enabling further investment in staff and new machinery. |
| | • Inject 2 – specific evidence of improvements in operational capabilities supporting the consistent running of machines and processes to ensure consistency and reduce errors. Improvements in product and tooling design to support the introduction of new business by adapting product designs to improve manufacturability and reduce cost. Development of tooling designs and manufacturing capabilities to enable short-run, high value added manufacturing, leading to further introduction of new process equipment. |
| | • Build – specific evidence of on-site process improvements to solve problems that are now captured in formal systems and transferred across projects, helping to improve consistency in subsequent projects. The design team, with suppliers, introducing new building techniques to reduce costs, improve consistency and reduce build programme duration, aiding the winning of new business and supporting the implementation of innovation originating from suppliers. |

| | **Appendix 2b**<br>**Evidence from the less effective improvers** |
|---|---|
| **How** | **Developing solutions individually**<br>• Eng 2 – specific evidence of operators changing processes and not documenting changes<br>• Inject 1 – some evidence of operators changing process settings resulting in changes to product characteristics and non-conformances<br>• Sysint – consistent evidence of the project engineer developing software without support from management to develop formal procedures |
| | **Largely individuals making changes to production and inspection procedures**<br>• Eng 2 – consistent evidence of senior management developing and implementing formal procedural changes without engagement of operational staff<br>• Inject 1 – some evidence of project and quality management staff developing procedures individually<br>• Sysint – specific evidence of the project engineer developing procedures without support from management to develop formal procedures |
| **Support and Engagement** | **Limited involvement by the firm in product development**<br>• Eng 2 – specific evidence of only ad hoc involvement in refining existing product designs<br>• Inject 1 – specific evidence of the acquisition of work with pre-approved tooling, leaving limited opportunities for development<br>• Sysint – specific evidence of only key personnel informally discussing product development opportunities with customers |
| | **Limited involvement of personnel in any product development that takes place**<br>• Eng 2 – specific evidence of only the Managing Director being involved in product development<br>• Inject 1 – limited evidence of direct involvement in the development of products, with only the project manager working with customers<br>• Sysint – specific evidence of only key personnel informally discussing product development opportunities with customers |
| | **Investment in product equipment to carry out current business**<br>• Eng 2 – some evidence of investment in new machinery to replace existing, outdated machinery<br>• Inject 1 – limited evidence of investment in new machinery, primarily using existing, under-utilised machinery<br>• Sysint – some evidence of engineers learning about new process technologies, but limited opportunities to apply learning, but management attention focused on refining personal approaches to writing software |

| | |
|---|---|
| **Some benefits but persistent problems** | **Effects of process improvement activities, and persistent and/or recurrent problems**<br>• Eng 2 – some evidence of cost and cycle time savings through involvement with customers and transferring improvements across products during ad hoc new product introduction. Operators unwilling to engage in formal improvement practices, creating problems with following procedures leading to repeated errors from resistance to changed practices. Risks expressed of staff leaving the firm following training on new equipment.<br>• Inject 1 - limited evidence of improvements occurring with operators focusing on refining previously approved procedures and resisting formal changes to practice. Some support from external parties and internal improvement activities promoting improvements, but operators not engaging with improvement activities nor adhering to new procedures, and reverting to previous practices over time leading to repeated errors. Lack of involvement in product development work meaning work primarily won on direct, price based competition.<br>• Sysint – some evidence of improvements in project coordination resulting from the implementation of formal procedures but operational problems frequently recurring due to inconsistencies in individual engineers' practice. The need for changes in practice not demanded/mandated by management, enabling error creating practice to continue and not formally addressing issues of poor attitudes of engineers that prevent the sharing of ideas and insights. Lack of formal involvement in the development of projects with customers limiting opportunities to add value, with projects being won on cost. |

| | **Appendix 3**<br>**Evidence of Effects** | |
|---|---|---|
| | **More effective improvers** | **Less Effective improvers** |
| **Effect 1** | Individuals' willingness to reflect on own perceptions of practice and question established approaches to operating and change behaviours<br><br>• Eng 1 – operators reflect on existing practices when informed of problems to consider new approaches (Effect 1.1)<br>• Inject 2 – operators accept feedback and change practices to prevent reoccurrence (Effect 1.1, 1.2)<br>• Build – project managers accept new ways of operating in an effort to improve project outputs (Effect 1.1, 1.2) | Individuals maintain personal perceptions of PI as an individual activity that results from trial and error<br><br>• Eng 2 – incremental changes to practice to make operations easier or quicker (Effect 1.1, 1.2)<br>• Inject 1 – established practices of refining machine settings to reduce cycle times (Effect 1.1, 1.2)<br>• Sysint – individually developed expertise and refinement of practices as a result of experience (Effect 1.1, 1.2) |
| **Effect 2** | Individuals able to contribute personal knowledge to group problem solving and development of processes<br><br>• Eng 1 – individuals proposing ideas in group discussions that are combined and refined to develop solutions (Effect 2.1, 2.2)<br>• Inject 2 – contributing process understanding to group discussions (Effect 2.1)<br>• Build – Individuals drawing from past project experience to develop solutions with other project managers (Effect 2.1) | Resistant to sharing individually developed approaches to working in groups and not capturing solutions<br><br>• Eng 2 – operators unwilling to share individually developed approaches with colleagues or management (Effect 2.1)<br>• Inject 1 – production personnel unwilling to be involved in improvement activities and limited procedures in place (Effect 2.1, 2.2)<br>• Sysint – attitudes of individuals stopping the sharing of ideas in group settings and procedures not followed for particular activities(Effect 2.1, 2.2) |
| **Effect 3** | Management support given to all problem-solving activities at all levels, including personal support to change individual perception of PI<br><br>• Eng 1 – QMS integral to operations with personnel and resources directed to PI (Effect 3.1, 3.2, 3.3, 3.4)<br>• Inject 2 – QMS supported and individuals given time, resources and support by management to make improvements to change practices (Effect 3.1, 3.2, 3.3, 3.4)<br>• Build – QMS implemented as company strategy, formal project manager meetings supported, and design teams to develop product designs (Effect 3.1, 3.2, 3.3, 3.4) | Management not actively involved in engaging or supporting operational staff in PI or in accepting procedures<br><br>• Eng 2 – use of procedures supported by management but resources not given to involve operational staff (Effect 3.1)<br>• Inject 1 – limited evidence of presence of operational procedures and production staff focused on delivery related issues (Effect 3.1, 3.3)<br>• Sysint – resources provided to group discussions but the use of software writing procedures not actively supported (Effect 3.2, 3.3, 3.4) |

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| **Effect 4** | Involvement in group problem solving affects individual perceptions of solutions and PI activities, improving acceptance of solutions<br><br>• Eng 1 – group discussions build on operator understanding to develop solutions<br>• Inject 2 – groups of operators given responsibility for proposing their own solutions<br>• Build – developing and justifying solutions based on the experience of peers | Lack of involvement and acceptance of group activities, maintaining existing perceptions<br><br>• Eng 2 – procedures justified with the need to maintain accreditation with operators not involved in changes<br>• Inject 1 – individual operator practice focused on individual expertise<br>• Sysint – involvement in group discussion not linked to changes in practice |
| **Effect 5** | Organisational procedures become accepted behaviour for individuals<br><br>• Eng 1 – procedures seen as integral to directing individuals behaviour<br>• Inject 2 – procedures viewed as documented best practices to be adhered to<br>• Build – procedures stipulated by management as necessary to key customers and improving consistency of projects | Individuals maintaining personal PI approaches and personal operational behaviours<br><br>• Eng 2 – operators diverging from procedures when not directly observed<br>• Inject 1 – lack of supported procedures affecting operator behaviour<br>• Sysint – management accepting that individuals carry out work in different ways with different results |
| **Effect 6** | Deliberate changes to product designs and processes (OL) provide reductions in cost and lead time, leading to further introduction of additional development work with new and existing customers.<br><br>• Eng 1 – reductions in product costs through redesign leading to repeat and increased volume of orders (Effect 6a, 6b)<br>• Inject 2 – improved production consistency and the acquisition of design and development short run, high value-added production work (Effect 6a, 6b)<br>• Build – significant reduction of lead-time leading to winning business and moving into other sectors (Effect 6a, 6b) | Limited ad hoc and gradual operational improvements but improvement efforts not contributing to long term firm development<br><br>• Eng 2 – changing production methods to reduce cost and improve profitability (Effect 6a)<br>• Inject 1- address short term customer quality concerns (Effect 6a)<br>• Sysint – reduction in the number of errors in material ordering but limited evidence of improvement in software writing procedures over time (Effect 6a) |