

Managing supply chain collaboration in high-tech aerospace industry

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Summary Abstract

Step changes in supply chain performance cannot be enacted unless collaboration exists between buyers and suppliers, and encourages the right connections and commitments. We aim to improve the understanding of the supply chain collaboration and its critical success factors within the aerospace industry and the interactions and links between these factors. Upon reviewing literature, propositions are conceptualised for this industry. These are then verified through a case-study involving a series of interviews by the stakeholders and managers of a major European company in this industry. Finally, a steering model and a strategic framework are developed.

Keywords: Supply Chain Relationship, Supply Chain Collaboration, Aerospace Industry

Aerospace industry and supply chain relationship (SCR):

Aerospace industry is characterised by high interdependence within their supply chain (Tiwari, 2005). Fine (2000) describes supply chain management (SCM) as a company's ultimate core capability. Supply Chain Relationships (SCR) refers to the interaction between exchange partners that form a supply chain to improve competitiveness of both buyers and suppliers (Parsons, 2002). Both parties should seek 'partnerships' based on: mutuality, cooperation, reducing conflict, avoiding interpersonal inconsistency, accepting power dependence and trust (Johnsen et al, 2008). However, as observed by Cox (2003) supply chain relationships can deliver performance even in the presence of miss-trust, adversarial, power driven behaviour and conflict. This suggests a need for a better understanding of the trade-offs between main SCR success factors in the context of aerospace industry. Table-1 reviews SC collaboration factors within the existing literature and offers propositions, conceptualised to the aerospace domain, using these facts and factors to be later verified in this research.

Table 1 – Literature review and proposition development

Theme	Fact and factors from literature	Propositions (conceptualised for this research and the case company within Aerospace)	Prop. Id.
Competency –Based SC alignment (Lean vs Agile)	Superior performance of firms can be achieved through their ability to accumulate resources and capabilities that are rare, valuable, and difficult to imitate, which in turn enable them to create and maintain competitive advantages and competencies (Hinterhuber, 2013)	Collaboration is more likely to take place with suppliers with rare capabilities and those with add to the company’s core competencies	PSC
	Agile and responsive suppliers in fast evolving markets will add to sustainable competitive advantages (Richey Jr et al., 2009)	Agile suppliers that can also offer design and innovation capabilities improve firms’ competencies and are considered as strategic suppliers.	PAC
	Lean production can underpin competitive advantage if the firm is able to appropriate the productivity savings it creates (Lewis, 2000).	Lean Suppliers that can offer cost reduction and high efficiency improve firms’ competencies and are considered as strategic suppliers.	PLC
	High collaboration with key suppliers secures higher levels of effectiveness and efficiency (Min et al., 2005)	Collaboration with suppliers must be pursued when cost reduction and efficiency improvement is needed	PSL
	Volume and variation (product variety demand variation and product life-cycle) are the main distinguishing attributes between lean and agile SC (Christopher and Towill, 2001). Product complexity includes design issues such as the number of nonstandard components in a product, and needs a more agile SC to manage it (Christopher, 2000)	The volume of supplied parts and assemblies is an important factor on lean or agile supply chain selection.	PVO
		The variation of demand and design of the supplied parts and assemblies is an important factor on lean or agile supply chain selection.	PVA
The Complexity and criticality of the supplied parts and assemblies is an important factor in lean or agile supply chain selection.		PCL	
Managing SC Relationship & Power Balance	Sustaining attraction so that it becomes commitment and collaboration is necessary (Laing and Lian, 2005). Despite the drive for dominance, companies wouldn’t enter into business agreements if they were not attracted to each other (Cordón et al, 2012).	Relationship with the SC and balance of power between the firms and their suppliers affects the level of collaboration and partnership between the parties.	PSS
	Håkansson and Snehota (1995) argue that only a limited number of relationships have an important impact on a company's performance. Besides, Ellram and Edis’ (1996) research concluded that an important barrier to collaboration includes too many suppliers being treated as key suppliers.	Supply chain relationships which develop competencies may change the power balance in SC.	PCO
	The constructs of “attraction” are trust and dependency (Nyaga et al, 2010). Trust is at the heart of a collaborative and long-term SC relationship, and without the foundation of trust no SCR can be built and sustained (Fawcett et al., 2012)	The level of trust between firms and their suppliers affects their relationship and power balance and vice versa.	PTS
	Choosing the right lean, agile or leagile suppliers helps firms to manage a long term and mutually beneficial relationship with their suppliers (Bruce et al., 2004)	Right supply design (lean versus agile SC) directly affects SC relationship and influences the power balance.	PLS

	Firms that seek SC responsiveness should work towards building greater levels of trust with their key suppliers, and giving them some independency to manage their own suppliers (Handfield and Bechtel, 2002)	Suppliers must be given some degree of freedom to manage their own upstream supply chain	PTU
Integration and upstream SC management	Internal concurrent engineering processes and cross-functional teams help firms to better understand and improve their relationship with their key suppliers (Willaert et al., 1998)	Internal cross functionality and concurrent engineering enhances firm's understanding of the power balance and empowers SC relationship	PCS
	There is strong positive relationship between cross-functional team building, internal integration and customer-oriented performance of the firms (Huo, 2012)	Cross functional teams and concurrent engineering improves internal integration and ultimately improves responsiveness to the customers' values.	PCF
	An aid to variation reduction and, hence, enhanced agility will be the development of a human resource strategy that leads to increased level of internal integration (Christopher, 2000)	Internal integration reduce the imposed variation on SC	PIV
	Competitiveness and attractiveness of a company can increase if internal key activities and business processes are linked and well-managed (Lambert et al., 1998)	Internal integration makes the buyer more attractive to its suppliers.	PIP
	Quantitate result from 617 companies, studied by Huo (2012), showed internal integration improves external and supply integration.	Internal integration is essential for SC integration	PIS
	SCI works best in circumstances when there is an interdependence in the power relationships between them (Cox, 2003).A strong attraction, that is supported by appropriate information sharing, and relational effort to balance trust and dependency manifests in commitment (Nyaga et al, 2010; Pardo et al, 2011).	SC integration and information sharing increase trust between parties and also can be used to control suppliers	PST
	Integration with supplier through sharing information with them leads to a better financial performance and cost reduction of the buyers (Hou, 2012)	SC Integration and Information sharing leads to efficiency and cost reduction	PSI
	Integration with supplier in the form of information sharing improves their dependency (Handfield and Bechtel, 2002)	Supply chain integration and information sharing helps suppliers to better manage their own upstream SC network	PSU
	Suppliers with upstream SCM capability can improve efficiencies (Dyer and Hatch, 2004)	If suppliers are trusted to manage their own SC network, they may be able to do it more efficiently.	PUL
	Suppliers with clear resource management strategies and SC network design capability are more desirable as key partners and suppliers (Lockamy and McCormack, 2004)	Suppliers with upstream SC management capabilities are more attractive.	PUP

Research Method

Similar to de Leeuw et al. (2009), we deployed an exploratory research design to enhance our understanding of the SC collaboration success factors. Reviewing literatures in this domain, we drafted a set of propositions and adapted them to the context of the aerospace industry. A case-study on one of the leading European original equipment manufacturers (OEM) in the aerospace industry was taken to verify the propositions and develop a model. Our framework is being newly developed in this study; therefore our research is more exploratory than confirmatory, thus requiring qualitative data for development (Perry, 1998). A single case

study is considered appropriate for theory and framework development (Eisenhardt 1989). It can particularly be justified when it consists of a unique case or a case that was not widely accessible to significant scientific investigations (Yin, 1994), as is the case for the aerospace industry. A series of semi-structured interviews were conducted in 2014 with senior executives within financial, engineering and purchasing functions of the case company (see Table 2 for details). This involved open-ended interviews with senior managers concerning a recent and successful SC experience. This was then used in the design of further semi-structured questions for a focus group study with specialists and different stakeholders within the value chain (see Table 2). Focus groups are particularly useful when the objective is to explain how people regard and experience an idea or event (Krueger, 1994). The theme for the focus group was “how can we work smarter with our supply chain?” in order to have the group explore the dynamics of the supply chain relationship and collaboration.

Taking the same approach used by Zsidisin and Smith (2005), open, axial and selective coding analysis was implemented on the data generated through interviews and focus group, in accordance with the guidelines set by Yin (1994). To analyse, conceptualize and develop categories for the data, open coding was employed, followed by an Axial coding to make connections among categories and to summarise the issues into themes. Then, selective coding was employed to integrate the research findings into an overall theory.

Table 2 - Organisational functions of the interviewees and the members of the focus group

	Organisational Functions	Abbreviation
Interview	Executive Vice President 1	EVP1
	Executive Vice President 2	EVP2
Focus Group	Buyer (Purchasing Specialised)	SP-BUY
	Global Commodity Leader (Purchasing Specialised)	SP-GCL
	Buyer (Purchasing Specialised)	SP-BUY
	Global Commodity Leader (Purchasing Specialised)	SP-GCL
	Cost Work Package Owner (Engineering Specialised)	SP-WPO
	Manufacturing Engineering Lead (Manufacturing Specialised)	SP-MECL
	Global Engineering Commodity Leader (Engineering Specialised)	SP-GECL
	Project Cost Manager (Customer Facing Business Unit representative)	SP-CFBU

Discussion and Conclusion

Appendix 1 illustrates evidences from the interviews and focus group studies to back up and verify the propositions. Based on the propositions (Table 1) and the empirical evidence (Appendix 1), a steering model for SC collaboration is developed as shown in Figure 1.

This model highlights the factors affecting SC collaborations, within the main three categories of ‘Competency-based SC alignment’, ‘Managing SC relationship and power balance’ and ‘integration and upstream SCM’, as categorised in Table 1. This models explains that to achieve the right level of SC collaboration two major domains must be understood by aerospace OEMs, comprising the dynamics of competency development through key lean or/and agile supply chain firms, as well as the power balance with the key suppliers.

Internal integration (cross-functional teams and concurrent engineering) and integration with key suppliers are the main enablers which feed to both competency developments and power balance management.

Key suppliers that add to the OEMs’ core competencies (through offering agile and/or lean resources), must be trusted to manage their own upstream supply chain with OEMs’ supports, but with minimum interference. This upstream supply chain management approach along with

integration and information sharing with the entire chain secures the right level of efficiency and cost reduction, and makes the whole supply chain leaner.

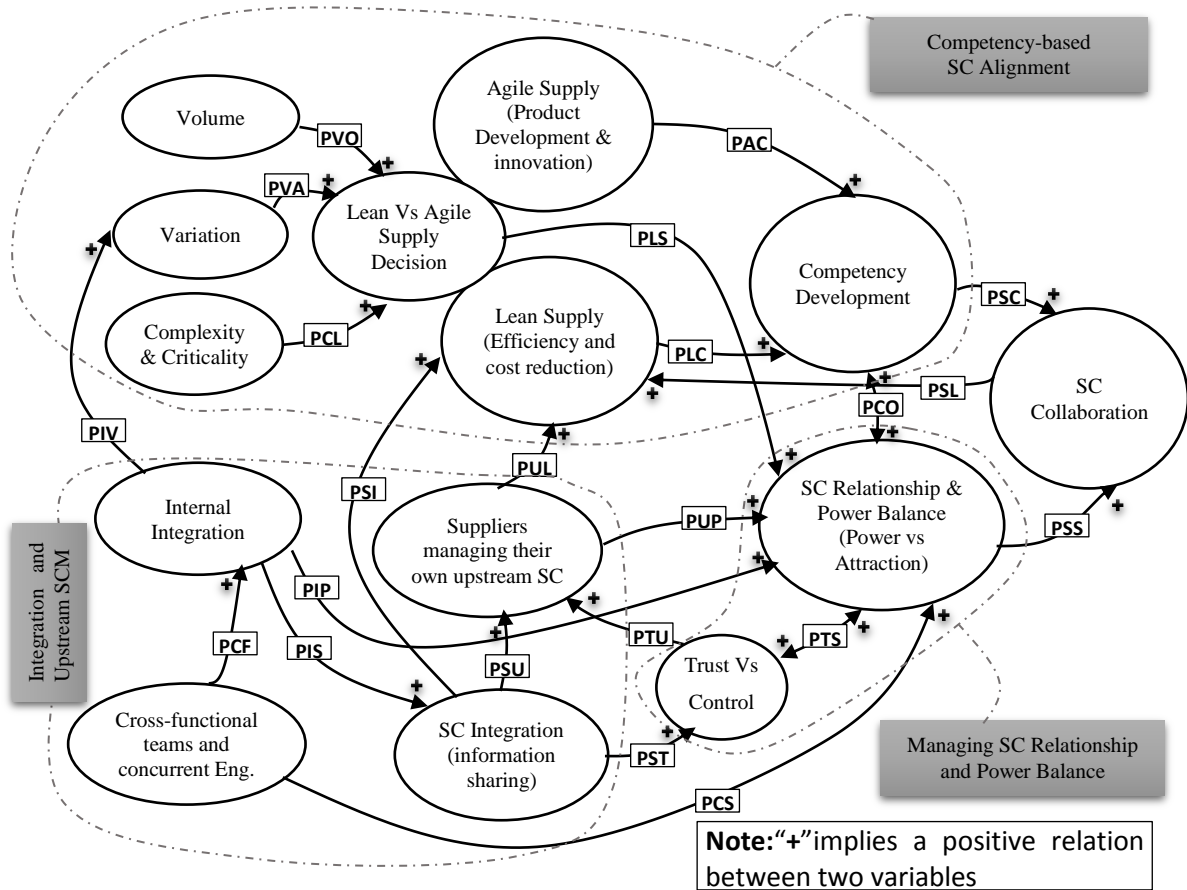


Figure 1 – a steering model for SC relationship and collaboration in Aerospace industry

To conclude, Figure 2 shows a model for a step by step SC collaboration development (outside-in arrows in Figure 2), as well as SC collaboration policy deployment (inside out).

Outside-in policy making steps in Figure 2 indicates that to achieve the right level of SC collaboration with key suppliers, OEMs should first decide on the following steps: lean/agile supply needs (a product/project base decision, dependant on variety, volume and complexity of products/projects); SC development programmes; trust-building policies; upstream supply chain strategies; and internal and external integration decision. Based on this first layer of policy-making, the second strategic layer is to discuss whether or not collaboration with each of the key suppliers adds to the competitive advantage of the OEM. This will influence how the power balance between the firm and the supplier must be managed and how much integration with the supplier is needed.

Besides, supply chain collaboration policy deployment steps (inside-out arrows in Figure 2) illustrate how an OEM’s SC collaboration strategy can be operationalised in practice. It explains if a firm decides to keep a certain level of collaboration with a key supplier, then they must assess if this collaboration level fulfils the competency development/maintenance needed for the firm; and if so what kind of relationship is needed with that particular supplier, how much integration and information-sharing is needed with the supplier and how they must

be trusted and authorised to manage their own upstream supply channels. These strategic decisions then can be operationalised at the third layer, by understanding lean vs. agile supply requirements, choosing the right SC development plan, trust-building tactics, practicing upstream SCM flexibilities, and internal and SC integration management techniques.

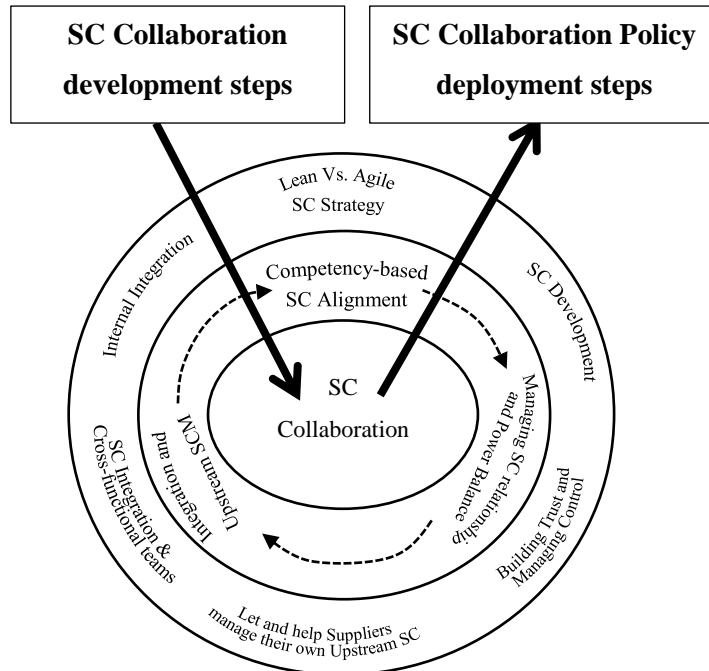


Figure 2 – Different layers of SC collaboration development and policy deployment in aerospace

Although this study sheds some light on the success factors for successful supply chain collaboration within aerospace industry, some limitations are yet to be addressed by further research in this area. These limitations include the single case-study approach in this research, and the lack of policy deployment details and techniques in this research. Besides, a need for a better understanding on how these factors are differently defined or understood within the aerospace industry comparing with other manufacturing, and how these findings sets SC collaboration in the aerospace industry different from other manufacturing industries is also evident, which is currently under an ongoing investigation by the authors and results will be published accordingly.

Acknowledgement

We would like to thank Mr Kevin Baldwin for the data collection, and the Nottingham Trent University and Professor Baback Yazdani for supporting this research.

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Appendix 1: Proposition verifications and evidences from interviews and focus group studies

Prop ID	Focus group and interview evidence
PAC	<p>SP-WPO: "What we really need to do is innovate but we can't work with every single supplier. [we must] focus our efforts on that innovation to yield benefits."</p> <p>EVP2: "Partnering works well with design make suppliers if we can be sure that we have options and do not become too reliant on them (mitigation plans)"</p> <p>EVP1: "There are some design-make suppliers and their sub-tiers that we want to develop new capabilities with... to get a world class product in return. Development is collaborative, and often with maintain suppliers."</p> <p>EVP1: "The top-level parts are assembled by the suppliers we deal with directly, particularly the components on new programmes where we are developing new technologies. Being agile and responsive is my priority."</p>
PCF	<p>EVP2: "At the same time as ensuring we get the best from supply chains we need to work together internally, ensuring each functional area understands the processes that the teams have to work to. This will allow information to be shared earlier and help us be even more responsive to our customers."</p> <p>SP-WPO: "We should really set ourselves up to work together anyway, rather than having the engineering guys in one place, the purchasing guys in another, with the manufacturing experts somewhere else. Co-location would help a lot."</p>
PCL	<p>EVP2: "A number of years ago we looked at outsourcing everything to lean suppliers, and it was fairly successful for simpler, stable, long running demand parts, but the more complex parts with expansive BOM did not work so well with the lean model. Having agility is just as important"</p> <p>SP-GCL: "It depends on the complexity of the parts. As an example [**part name is removed due to data sensitivity] are fairly handcrafted and the reason we keep them in house is because of the capacity needed to make them. We are looking at lean principles to improve the manufacturability of them, but we cannot outsource them to a lean specialist as they may not have the skills to make parts with inherent quality variability traits."</p>
PCO	<p>EVP1: "We are attracted to suppliers that offer us competences that we do not possess ourselves, and likewise suppliers are attracted to us as we offer a route along the value chain to end customers."</p>
PCS	<p>EVP1: "To get ourselves in the best position and make the most of supply chain relationships, we need to continue what we're doing – embedding cross functional teams, breaking down the functional silos and intelligently considering strategies with each supplier to determine how we should manage them; you know in terms of extent of collaboration and understanding power balance."</p> <p>EVP2: "Attraction is sensitive though. I know that our processes and procedures can be a pain and we can be perceived as a difficult customer."</p> <p>EVP2: "...it is relied upon sharing information internally across engineering, purchase and aftermarket areas as well as with the supplier. Once the balance of power is understood, only then can we align ourselves to identify negotiation levers."</p>
PIP	<p>SP-GCL: "We need to use the integrated commodity strategy process as a tool to get all parties together to really add insight into who we need to work with, and how whilst trying to behave in a way that makes us more attractive to work with than our competitors."</p>
PIS	<p>SP-GECL: "we need to align our functional business activities and processes to be on the front foot to help manage the supplier relationship."</p> <p>SP-CFBU: "Suppliers can also talk to my team to keep in the loop with customer requirements."</p>

PIV	<p>SP-BUY: “For a start, being kept in the loop about engineering changes would help to reduce the variations and let suppliers be more efficient.”</p> <p>SP-CFBU: “And also, don’t forget that you can tell us if customer requirements are beyond the capabilities the supply chain has – push back can stop some of the fluctuations in requirements and help us to all focus on the key issues.”</p>
PLC	<p>SP-GCL: “I’m attracted to strategic suppliers that can offer innovative ways of doing things that will save us money. Cost reduction is a strategic priority.”</p> <p>SP-WPO: “80% of our engineering cost reduction value this year has come from a few suppliers that we work together closely with.”</p> <p>SP-CFBU: “Attraction is simple – we all want to make money.”</p>
PLS	<p>EVP2: “understanding where we need to use both lean and agile approaches is key as relationships are immediately on the wrong foot if ours and suppliers expectations do not match, meaning that opportunist suppliers could seek to use a miss-matched situation to claim the balance of power.”</p> <p>EVP1: “The top-level parts are assembled by the suppliers we deal with directly, particularly the components on new programmes where we are developing new technologies. Being agile and responsive is my priority, but if lean can improve my supply chain I’ll happily listen.”</p> <p>SP-WPO: “We have to match the products into the right types of supplier because if we don’t, how can we expect to use relationships to drive improvements and innovation?”</p> <p>SP-CFBU: “Our customers want engines on time at the right cost, so we need to blend the best of both lean and agile.”</p>
PSC	<p>EVP1: “collaboration only works whereby we need the supplier for rare capabilities, and they need us for access to markets”</p> <p>EVP2: “Partnering works well with design make suppliers”</p> <p>SP-GCL: “We have segmented by criticality and spend, and should focus our collaborative efforts with our strategic or growth suppliers”</p> <p>SP-WPO: “What is the point of partnering with suppliers who only make us simple parts that we can get elsewhere?”</p> <p>SP-GCL: “Going back to criticality and spend segmentation, our decline or exit suppliers are the ones we should keep at arms-length so we can focus on our strategic and maintain suppliers”.</p>
PSI	<p>SP-WPO: “I’ve found for my engineering cost reduction projects that success is only possible by working together and sharing information both internally and externally as part of a cross-functional project team. “</p>
PSL	<p>SP-MECL: “We need to be lean, so we have to work together”</p> <p>SP-CFBU: “Be pragmatic – if a supplier needs our help to take out cost, then we should collaborate. If they are getting along OK with no issues, keep at arm’s length and don’t burden ourselves; we only have so many resources”.</p>
PSS	<p>SP-GECL: “I think it depends on each supplier. For our simpler parts that we could switch supply chains I’d be more than happy being the dominant party and I could easily make a business case as my resource involvement in managing the relationship would be low. For more complex parts where we have to change information or design changes and tweaks are the norm I would prefer to have a cross-functional IPT [integrated project team] working with the supplier to ensure interdependence and part manufacturability. Our problem parts are the ones that we cannot switch because the supplier has set up manufacture using proprietary processes that other suppliers cannot manage, meaning they have the power.”</p> <p>SP-CFBU: “Well, everyone is out to make money, and if a supplier holds the power over us there’s always the risk of price increases. We can either accept that risk, or try to reduce the risk by doing something to make the relationship more reciprocal. What we would have to do depends on getting our ducks in a row internally, and how we would approach depends on how involved we really can commit to being so we’re not breaking promises.”</p> <p>EVP2: “Once the balance of power is understood, only then can we align ourselves to identify negotiation levers.”</p>

PST	<p>SP-BUY: “My view is that we should collaborate and seek mutual benefits and interdependence.”</p> <p>SP-BUY: “How would we know what suppliers are up to if we are not working with them?”</p> <p>SP-MECL: “Sometimes we do not live up to being the attractive customer that we claim we are. Our processes are a minefield and the way we share information is too variable and often late.”</p>
PSU	<p>SP-GCL: “I push for directed buy deals with raw materials and [**Part class is removed], so all of our suppliers in contract can benefit from our supply chain network”.</p> <p>SP-CFBU: “We need to adapt our approach and manage supply chains appropriately. If we can get a better deal than a supplier on raw materials, get them signed up. If we can’t, surely we can use that knowledge as a lever in our own negotiations to lower costs elsewhere in the business?”</p>
PTS	<p>EVP1: “Mutual attraction comes from trusting each other. And trust is not necessarily achieved by collaborating, but by simply meeting the promises we make to each other.”</p> <p>EVP2: “There are some suppliers that we are heavily dependent on, so trust is important in helping us achieve objectives. Otherwise the power-balance can shift to the supplier and there is a risk of opportunism as it is very difficult to switch supply chains of highly complex products.”</p> <p>SP-GECL: “There is an attraction to working with them [a few suppliers with cost efficiency and lean capabilities], and whilst on the one hand the engineering guys have built up trust to change designs, ultimately we couldn’t have built up enough trust across the board to mitigate the commercial increases.”</p>
PTU	<p>EVP2: “I’ve been involved in purchasing programmes with some of our suppliers whereby we have attempted to influence the supply-chain network, for example by directing our first tiers where to buy their castings or semi-finished parts from. To be honest, this was problematic ...”</p> <p>EVP2: “a reason for past failures was that we misunderstood the nature of the relationship, and ours and the suppliers’ wires were crossed.”</p> <p>SP-BUY: “In an ideal world we need to manage the whole supply chain, but that’s just not possible in this industry.”</p>
PUL	<p>EVP2: “[Previous experience of influencing upstream SC] was problematic as our varying demand signals kept causing a bull-whip effect that choked the supply chain, and the complexity and quality requirements of our end products make switching costs too high. The ‘big-boy’ suppliers do not need our ‘help’.”</p> <p>EVP1: “The depth of the supply chain that we should seek to influence really depends on the nature of the relationship with the first-tier supplier. One size doesn’t fit all. In some cases the suppliers we buy from have better relationships with sub-tiers than we do and can get better deals.”</p> <p>SP-MECL: “The directed buy deals in place in some instances are not as good as what our suppliers can get anyway because of their relationships, so could the effort expended in these areas be redeployed to other projects?”</p> <p>EVP1: “The suppliers we work with have lean or low cost manufacturing capabilities downstream, and they usually use these facilities to manufacture simpler sub-assemblies.”</p>
PUP	<p>EVP1: “In some cases the suppliers we buy from have better relationships with sub-tiers than we do and can get better deals. Some of our suppliers have vertically integrated and that is an attraction for us as it reduces the interfaces we need to manage.”</p>
PVA	<p>SP-GECL: “Relationships are frayed with the supplier of the [**Part name is removed due to privacy] because we’re pushing for flowlines whilst looking to change design. They are finding it impossible to lean out manufacturing, and we’re not getting parts on time. They’ve said they can give us the best of both if we stop making changes.”</p> <p>SP-CFBU: “For me our stable parts should be from lean supply chains, and our lower volume variable parts need to come from agile supply chains.”</p>