

Safeguarding the Promise of Production Outsourcing

Jason Amaral

Emeraldwise, LLC, PO Box 620720, Woodside, California 94062, jamaral@emeraldwise.com

Corey A. Billington

IMD International, Ch. de Bellerive 23, PO Box 915, CH-1001 Lausanne, Switzerland, corey.billington@imd.ch

Andy A. Tsay

Leavey School of Business, Santa Clara University, OMIS Department, 500 El Camino Real,
Santa Clara, California 95053, atsay@stanfordalumni.org

Today's product companies (original equipment manufacturers, or OEMs) increasingly outsource production, especially when the activities are asset intensive or require process technologies characterized by rapid innovation. When such an OEM also outsources the procurement of the required materials, especially to the party providing the production services, the OEM risks unpleasant surprises, such as unauthorized part or supplier substitutions, overbilling, mistreatment of the supply base, and the loss of the OEM's procurement leverage. Based on supply chain audits and interviews in numerous industries, we propose and analyze strategies for preventing these outcomes when outsourcing production. We recommend that OEMs carefully consider the underlying means, motives, and opportunities of the service providers when deciding which activities to outsource and how to establish effective business controls. Firms such as Hewlett-Packard, Motorola, and Dell have implemented these ideas.

Key words: manufacturing; strategy; inventory; production; outsourcing.

History: This paper was refereed.

In September 2004, *Purchasing Magazine* awarded its Medal of professional excellence to Hewlett-Packard (HP) for the second time (Carbone 2004). It recognized HP for procurement practices in such areas as managing risk, analyzing spending, managing supplier relationships, e-procurement, and buy-sell systems (HP's methods for buying components directly from suppliers in private transactions and immediately reselling to contract manufacturers). These procurement practices helped HP to save \$1.2 billion in production materials, to reduce supply chain costs by 22 percent, and to lower inventory by 21 percent.

But the outcome might have been different.

Wolfgang Zenger, vice president of GPS [global procurement services], says in the 1990s HP outsourced a lot of its strategic purchasing to EMS [electronic manufacturing services] providers as well as its manufacturing. That proved to be a mistake. "We had given too much control to contract manufacturers," he says. HP lost a lot of visibility in the supply chain because its relationships with suppliers weren't as tight as they should have been (Carbone 2004, p. 46).

HP, the largest outsourcer of electronics assembly and logistics services, subsequently brought control of procurement back in house.

Like many companies, HP came to understand the risks of outsourcing multiple aspects of production, especially using a turnkey approach that gives a single service provider extensive responsibility and control. This practice can tilt the balance of power towards service providers and increase the difficulty of monitoring the outsourced processes.

We propose and analyze disciplined approaches to managing the procurement element of an outsourced production strategy so that such companies as HP can retain supply chain power and minimize risk. We base our conclusions on extensive research of more than a decade with global companies in various industries, including high-technology, automotive, aerospace, white goods, and apparel (Table 1). We audited the supply chains of 18 companies representing over \$40 billion in outsourcing spending and through interviews and roundtables gathered the thoughts of over 100 senior executives affiliated

Industry	Interviews	Roundtables	Audits
High tech	15 companies 41 individuals	19 companies 27 individuals	10 companies
Automotive/ industrial	2 companies 7 individuals	25 companies 26 individuals	1 company
Other	14 companies 25 individuals	48 companies 61 individuals	7 companies
Total	31 companies 73 individuals	92 companies 114 individuals	18 companies

Table 1: Our ongoing research of more than a decade with global companies in high-technology, automotive, and other industries included supply chain audits of nearly 20 companies representing over \$40 billion in outsourcing spending and interviews or roundtables with over 100 senior executives affiliated with the Institute for Supply Management, CAPS Research, the Stanford Global Supply Chain Forum, and the Procurement Sciences Institute. Approximately 68 percent of these individuals were from brand owners, 16 percent were from suppliers and service providers, and 16 percent were academics or consultants.

with the Institute for Supply Management, CAPS Research, the Stanford Global Supply Chain Forum, and the Procurement Sciences Institute. Approximately 68 percent of these individuals worked for brand owners, 16 percent for suppliers and service providers, and 16 percent were academics or consultants. In addition, many of the solutions we describe were designed and validated at HP while one of the authors (Billington) was vice president of strategic procurement.

The Outsourcing Decision and Conflicts of Interest

A firm must choose a division of labor in every endeavor, defining its own roles and ceding any remaining duties to other parties. Outsourcing is not an optional strategy but a fundamental practice.

Proponents of outsourcing commonly emphasize the firm's resulting ability to focus on those activities deemed core competencies for their strategic significance (Prahalad and Hamel 1990, Quinn and Hilmer 1994). By converting some fixed costs to variable costs, the firm can obtain financial and operational flexibility, and improve its return on assets. Outsource service providers ostensibly have superior cost structures due to specialization and scale economies and low risk because they balance the peaks in one customer's needs with the valleys in another's. They

offer potential clients access to these benefits. Some argue that outsiders provide better service with fewer headaches than would a company's own employees; the premise is that outsiders are easier to fire and therefore are more willing to please (Eccles and White 1988). But outsourcing need not be about replicating an existing function at lower cost or with improved quality. Occasionally an outside party may offer the quickest or even the only path to new capabilities that can transform a company (Hargadon and Sutton 2000, Linder 2004).

By outsourcing, however, firms can sacrifice critical capabilities, institutional and tacit knowledge, and long-term relationships. Communication between internal and outsourced functions can be difficult. Their dependence leaves firms susceptible to the service providers' underperformance, and their holding hostage critical assets (for example, scarce parts or custom tooling), using their clients' product or process knowledge to benefit the firms' competitors or even themselves becoming competitors. In many cases, the outcome has been disappointing (Earl 1996, Doig et al. 2001, Lakenan et al. 2001, Barthelemy 2003).

Some risks of outsourcing result from the complexity, fragmented decision making, and broken information flows in decentralizing, which can be corrected by redesigning processes and improving information technologies. Others, however, derive from deliberate actions by service providers that are not in their clients' best interests. Those debating outsourcing have not confronted such events in sufficient detail.

We borrow language from criminal justice to provide a framework for understanding root causes and preventative measures, not to label actors on either side as criminals or infer that their actions are illegal. All business relationships, including those with outsource service providers, are based on trust and some form of implicit or explicit agreement. Although some service providers may directly violate contract terms, problems are most likely when the terms are vague or silent. It is difficult to fault either party for interpretations that are self-serving.

Criminal investigators probe for a confluence of means, motive, and opportunity. A criminal act is a logical impossibility for a suspect without means or

opportunity. Motive is not as absolute a requirement, but its presence is a red flag to investigators.

An entity that outsources automatically creates means by ceding some measure of decision control to the service provider. The magnitude of the means is a function of the type of task outsourced and the degree of autonomy granted. For example, the means will be greater if a firm outsources both procurement and manufacturing, not just manufacturing, and even more so if it outsources them to the same party.

Motive begins with the expectation that independent economic entities serve their own interests first. The agendas of the firm and the service provider typically do not conflict completely, but it is naïve to presume that they will align perfectly. Outsourcing creates this divergence, as employees with a common stake in their employer's success are supplanted by an external enterprise that has its own employees and investors to satisfy. The motive is usually financial, so its magnitude is a function of the amount directly or indirectly at stake.

In outsourcing, a firm converts an internal function to a service procured from an outside party, and opportunity arises in the client's imperfect ability to dictate and monitor the provider's actions (which is only exacerbated by any geographic or cultural separation). For some activities, overseeing the provider may require such intimate involvement that the firm may be better off not outsourcing. We have observed apparel firms negotiate contracts of over 1,500 pages in procuring some complex services.

This class of conflict of interest is related to the general premise of agency theory (Eisenhardt 1989), which concerns relationships in which one party (the principal) delegates work to another (the agent). A problem arises when the principal's goals conflict with the agent's goals, and the principal has difficulty verifying the agent's actions. Researchers have used the principal-agent framework to analyze various classes of outsourcing relationships (Logan 2000, Bahli and Rivard 2003), including those that arise in supply chain settings (Tsay et al. 1998, Cachon 2003).

Incentive Risks in Procurement Outsourcing

Product companies (original equipment manufacturers, or OEMs) increasingly outsource the direct

manufacturing and assembly portion of production, especially when the activities are asset intensive or require rapidly changing process technologies. We refer to the provider of the manufacturing services as a contact manufacturer (CM).

These outsourcing OEMs automatically face another decision, whether to also outsource the procurement of the required materials. While this need not be to the CM, the magnitude of the financial impact can present a valid business case for coordinating manufacturing and materials decisions. This approach can prevent myopic actions, such as choosing a cheaper component without considering the resulting increase in assembly cost. Turnkey engagement of a CM, in which the CM is entirely responsible for providing the end product to the OEM, ostensibly produces tight integration with the least overhead while retaining the benefits of manufacturing outsourcing.

CMs have financial incentives to take over the OEM's procurement of direct materials, for which they typically earn a percentage markup over the cost of materials. In addition, because financial analysts sometimes base certain metrics on revenue, the ability to count the flow of materials as revenue can elevate a CM's public stature. In the electronics sector, for example, materials can represent 75 to 80 percent of a CM's revenue. At the same time, competition has caused a reduction in the margins that CMs can earn solely by manufacturing, and CMs cannot currently rely on end-market expansion to drive growth. Some CMs now view direct manufacturing as a loss leader for driving business through the profit center that procurement has become.

This practice by itself is not a problem. Any party providing a service of value is entitled to fair compensation. Such an arrangement, however, can inflict upon the OEM unintended consequences and unanticipated risks.

Control of the buying decision is an asset with potentially great value. The livelihood of any seller depends on making buyers happy, and sophisticated or large-scale buyers may be able to extract treatment from suppliers that is competitively advantageous. This preferential treatment can take the form of low prices (either straightforwardly or indirectly through rebates and other subsidies), short lead times, liberal return privileges, forgiveness of occasional

contract noncompliance, assurance of supply in times of scarcity, ability to influence technology road maps, technical support, and so forth. Thus, something more profound than a markup on materials changes hands when an OEM outsources procurement; the OEM may cede control of the preferential treatment as well.

The procurement function—and the OEM's procurement priorities—can be described along two dimensions. One dimension classifies procurement activities by what is being moved or exchanged (the supply chain flows):

- Physical activities to move goods and materials efficiently,

- Informational activities to communicate knowledge, instructions, reports, and data in a timely and secure manner,

- Financial activities to control payments, collections, and investments and ensure compliance with legal and regulatory requirements.

The other dimension concerns the type of procurement activity:

- Planning activities to determine future requirements and acceptable levels of risk,

- Execution activities to complete intended actions reliably,

- Management activities to resolve issues and improve performance and capabilities.

These two dimensions imply nine sets of procurement activities that an OEM can outsource to some degree, individually or in combinations (Table 2).

The OEM faces certain hazards in outsourcing each of the nine activities, because the CM can violate the OEM's intentions. The magnitude of the risks depends on the number and nature of the activities

outsourced, the motives of the two parties, and the business controls established (Table 3).

Planning—Physical (Table 3, Row 1)

By giving the CM the authority to determine the amounts of capacity and materials (perhaps from a list of approved suppliers and contracts), the OEM provides the CM the means to choose the supplier and the quantity to its own advantage. The inherent subjectivity of such decisions provides the opportunity.

OEMs and their CMs do not always have the same priorities when making trade-offs among such factors as assurance of supply, responsiveness, quality, and technical performance. The CMs may have less reason than the OEMs to be concerned with downstream technical performance and quality, and CMs also entrusted with the postsales repair contracts may actually prefer less reliable components.

One high-tech OEM found that its CM surreptitiously replaced a critical plastic component with a cheaper alternative and retained the difference in material cost. The inferior part failed several years later, punishing the OEM with brand damage and millions of dollars in service costs. Some OEMs have discovered that CMs included patent-violating components in products, requiring extensive scrap and rework. In other cases, CMs overrode the OEM parts preferences to get rid of their own surplus materials.

Some CM decisions are colored by financial agreements with suppliers in such forms as rebates, prebates, and ordering fees, some of which can readily be hidden or divorced from any specific transaction. For instance, a CM might buy one OEM's requirements

Action	Physical	Informational	Financial
Planning	(1) Planning physical flows, e.g., determining materials requirements	(2) Planning informational flows, e.g., forecasting demand	(3) Planning financial flows, e.g., negotiating terms with suppliers
Execution	(4) Executing physical flows, e.g., receiving goods	(5) Executing informational flows, e.g., placing purchase orders	(6) Executing financial flows, e.g., paying suppliers
Management	(7) Managing physical flows, e.g., rebalancing inventory across locations	(8) Managing informational flows, e.g., identifying exceptions and deviations from plan	(9) Managing financial flows, e.g., monitoring costs

Table 2: Procurement activities can be described along two dimensions, by their flows (physical, informational, or financial) and by their actions (planning, execution, or management). The resulting cells define nine sets of procurement activities that OEMs can outsource to some degree, individually or in combinations.

Procurement activities	Basis of opportunity	Means-motive-opportunity hazards
(1) Planning—Physical Determine the capacity and materials to support manufacturing	Deciding how much to order from whom is somewhat subjective.	Self-serving or myopic materials choices
(2) Planning—Informational Forecast demand and potential supply constraints	CMs can conceal poor forecasting within the inevitable errors.	Forecast manipulation
(3) Planning—Financial Select suppliers and negotiate terms and conditions	The OEM may lack visibility into the financial relationship between the CM and suppliers.	Self-serving or myopic supplier selection and engagement
(4) Execution—Physical Receive goods, assess quality, track inventory, and pick and stage parts for assembly	The CM gains physical possession of materials, whose location and status may be unknown to the OEM.	Diversion of materials
(5) Execution—Informational Place purchase orders and adjust quantity or timing	The OEM might provide guidelines but does not oversee every order the CM places. The OEM cannot review the reasonableness of order changes with suppliers.	Violation of purchasing intent Inconsiderate treatment of suppliers
(6) Execution—Financial Pay suppliers, receive rebates or reimbursements, and maintain transaction records	The OEM lacks visibility into the timing of cash flows. The CM can obscure individual transactions or charges. The CM can use knowledge of OEM supplier pricing to negotiate similar prices for itself or competing OEMs. Preferential treatment from suppliers can be decoupled from specific purchases.	Delaying of payments Incorrect billings Exploiting supplier pricing information Extracting noninvoiced concessions from suppliers
(7) Management—Physical Balance inventory across locations and expedite shipments from suppliers	The OEM lacks visibility into the inventory levels at assembly facilities around the world.	Inappropriate inventory balancing and freight expediting
(8) Management—Informational Identify deviations from plan and request contingent and corrective actions	The CM owns the raw data about procurement decisions and supplier performance, providing the OEM with only summary reports. Deviations from plan are difficult to anticipate and write into contracts, and corrective actions may be judgment calls.	Manipulating data and metrics Negligence in responding to problems and issues
(9) Management—Financial Monitor costs and asset utilization, and invest to strengthen supply base	Especially during crises, OEM managers may fail to enforce requirements for authorization of spending and deviations from contract. By contract, CMs can often pass on increases in materials prices and must share reductions, but their promptness is difficult to monitor. The competence of the CM is difficult to determine, especially the knowledge and skill of its employees.	Phantom charges Selective disclosure of changes in materials costs Underinvesting in support resources

Table 3: Outsourcing each of the nine sets of procurement activities creates specific means and opportunities for a CM to violate the OEM's intentions. The motive for doing so begins with the presumption that a CM will serve its own interests first. The magnitude of each means-motive-opportunity hazard depends on the number and nature of the activities outsourced, the amount at stake, and the business controls established.

from a particular supplier in exchange for attractive terms on a purchase for a different OEM.

Planning—Informational (Table 3, Row 2)

CMs that provide consumption forecasts directly to suppliers possess the means to manipulate these forecasts. Opportunity is present because forecasting is still as much art as science and forecasts are almost inevitably wrong, so the OEM cannot divine the quality of its CMs' forecasting methods or results or detect questionable intent.

When forecasts do not entail absolute requirements to purchase, buyers have an incentive to inflate forecasts. They thus ensure supply at someone else's cost. OEMs that manage their own procurement are certainly not innocent of this tactic, which can diminish trust and create supply chain inefficiencies by corrupting the quality of information flow (Lee et al. 1997). An OEM increases risk, however, whenever the CM has less vested in the relationship with a particular supplier than the OEM.

Planning—Financial (Table 3, Row 3)

In some arrangements, the OEM gives the CM the freedom to choose suppliers and negotiate contract terms and conditions. An OEM that removes itself from the sourcing process may ultimately lack expertise and context for assessing the CM's decisions. Under these circumstances the CM can make self-serving decisions regarding suppliers, components, and quantities. The OEM's lack of direct involvement in choosing qualified suppliers and negotiating contracts could lead to unexpected brand damage should the supplier turn out to be, for instance, an environmental or human-rights villain.

Execution—Physical (Table 3, Row 4)

When the OEM gives the CM the right to make and implement decisions about receiving goods, tracking inventory, and picking and staging parts for assembly, the OEM cannot be sure the CM will use the materials as the OEM intends. To surrender physical possession of materials is to forego a great deal of control.

When mission-critical parts are in short supply, OEMs use their efforts and relationships to obtain the scarce materials. Once these parts enter a CM's facility, though, the CM may shift them to other uses. This diversion may be unintentional or it may be a

deliberate attempt to curry the favor of other OEMs. Ambiguity regarding ownership of the inventory (for example, parts supplied because of the OEM's preferential status but paid for by the CM) can also lead to diversions if they are not forbidden by contract.

A CM might also thwart an OEM's attempt to redeploy scarce parts to another location (perhaps a different CM), especially if the CM believes it has a legitimate claim to the inventory. This issue was the focus of a lawsuit brought by the medical-equipment firm Beckman Coulter against its CM, Flextronics (Thurm 2003).

Execution—Informational (Table 3, Row 5)

OEMs typically qualify multiple suppliers and then instruct CMs to split the total purchase volume among the suppliers according to some fixed allocation, such as 50/50 or 40/30/30. The OEMs thus hedge against supply risk, maintain goodwill across a broad supply base, and preserve healthy competition among suppliers. Unless the OEM tracks every transaction, however, the CM has opportunity to violate such guidelines to its own benefit.

We found instances in which CMs purchased nearly the entire volume from the cheapest vendors (perhaps negotiating hidden price breaks or rebates) but charged the OEMs the higher, weighted-average prices implied by the recommended allocation. One OEM uncovered its CM's behavior only when trying to get parts during a shortage. The supplier sniffed, "What do you mean that you bought 50 percent of your volume from me last year? You didn't buy anything!"

While order expedites, postponements, and cancellations are inevitable consequences of the turbulence in demand, the OEM may be unaware of the frequency with which the CM makes such changes and the way the CM treats suppliers. To increase the likelihood of meeting their own commitments to OEMs, some CMs place inflated orders with multiple suppliers and accept only the earliest deliveries. Such inconsiderate behavior squanders suppliers' goodwill and creates extra costs that the OEM ultimately bears.

Execution—Financial (Table 3, Row 6)

When a CM controls cash flows to and from suppliers, and the OEM has not clearly defined the expected

rules of engagement with suppliers or is too distant to question specific actions, the CM can follow policies that differ from the OEM's in paying suppliers and managing returns. For example, a CM has the opportunity to delay payments, pad invoices to the OEM, exploit information about supplier prices, and extract concessions from suppliers:

Delaying Payments

To improve its own cash or credit position, a CM may delay payments to suppliers (by over 100 days, we found). It can thus undermine the financial stability of the supply base, jeopardize supplies and increase the OEM's ultimate costs for goods and services. When the suppliers are smaller and weaker than the downstream CM and OEM, the CM essentially forces the entity with the highest cost of capital to finance the supply chain's activities.

Billing Incorrectly

When the materials or services procured are complex and not routine, OEMs may lack visibility into individual transactions. OEMs willing to accept summary invoices and reluctant to comb through records manually leave themselves open to abuse. CMs may submit duplicate invoices or invoices containing excess overhead charges or errors in calculating rates and fees, errors that (in our experience) account for more than two percent of total expenditures. Although many such errors are unintentional, service providers seem most concerned with ensuring that they do not undercharge customers and overpay suppliers, rather than the reverse.

Exploiting Information About Suppliers' Prices

Large OEMs can often negotiate favorable prices on standard parts. Unless these OEMs take preventative measures, CMs acting as their procurement agents will have knowledge of these prices. Such CMs have bargaining advantage when seeking similar prices for other OEMs but may erode the supplier's willingness to grant the original OEM such preferential treatment. Or CMs who control information flows can simply order parts for other OEMs using the initial OEM's preferred price contracts without revealing the intended use. One OEM procurement manager observed, "The most a CM will pay is the least it knows someone else is paying." Such practices usurp

an OEM's buying power and diminish its competitive advantage.

Extracting Concessions from Suppliers

OEMs usually pay for CMs' procurement services as a percentage of the cost of materials. CMs can benefit from both sides of the transaction when suppliers accommodate CMs in ways not recorded explicitly as costs.

Management—Physical (Table 3, Row 7)

When CMs supervise inventory rebalancing across numerous assembly locations and decide if and when to use expedited shipment modes, including from suppliers, OEMs may have no visibility of inventory levels or of the reasons for excesses or shortages. OEMs may not agree with CMs' choices for rebalancing inventory or expediting freight. For instance, a CM may authorize air freight from suppliers, passing on the costs, to give itself more time to meet OEM orders.

Management—Informational (Table 3, Row 8)

When an OEM relies on a CM to monitor for deviations from plan and to evaluate the performance of the upstream supply chain, the CM owns the raw data and has firsthand knowledge about procurement decisions and supplier performance. Because encoding what transpires is difficult, the CM likely provides the OEM with only a summary. This creates opportunities for the CM to manipulate data and to address problems in ways the OEM might not prefer:

Manipulating Data

To manage the supply chain and improve its performance, the OEM needs accurate data and meaningful metrics (Lee and Billington 1992). When the CM is doing much of the reporting and interpretation of data, it faces a conflict of interest, in that the data reveals its own performance to the OEM. We have discovered situations in which a CM manipulated data or selected data to shift blame or to sugarcoat its actual performance.

Responding Poorly to Problems

Deviations from plan are inevitable but difficult to foresee. OEMs may not be able to draw up contracts, service-level agreements (SLAs), or scorecards that

allow them to measure and regulate how CMs interpret and respond to problems. OEMs may see CMs' responses as extreme or negligent, and the CMs may not have the perspective, experience, or incentives to draw conclusions similar to those the OEMs would draw.

Management—Financial (Table 3, Row 9)

When CMs are in charge of monitoring the costs and asset utilization of the inbound supply chain and investing in support resources and supplier development, and conditions change during the contract period, OEM managers facing tight deadlines may ignore rules regarding formal renegotiation and authorization for spending. Some possible outcomes are questionable charges, time lags in receiving material costs reductions, and inadequate levels of investment in personnel:

Phantom Charges

Some costs, such as those for emergency engineering changes, are notoriously difficult to quantify, and attempts to assign responsibility can trigger finger-pointing and arguments. Establishing liability for inventory is particularly problematic. For instance, a CM may penalize the OEM for the cost of excess parts even when the causes and effects of forecast changes are ambiguous and the inventories were never irreversibly committed to that OEM's use.

Selectively Disclosing Changes in Material Costs

During the life of contracts, CMs are entitled to pass on any increases in materials costs and must share any reductions. However, how quickly they must do so may not be specified, and monitoring is difficult. One OEM discovered that a CM was passing on cost increases for some electronic components in two days on average, whereas that CM typically took 23 days to share cost reductions. When caught, the CM apologetically and expeditiously rectified the oversight. But what of the undetected instances?

Underinvesting in Personnel

OEMs cannot easily verify the quality of human resources. One OEM reported that CMs exaggerated the qualifications of their procurement and process engineers and could not ensure input quality and resolve process defects, compelling the OEM to fly

expensive engineers from its US headquarters to the low-labor-cost regions for weeks at a time.

Alternative Approaches to Procurement in Outsourced Production

OEMs have implemented several alternative procurement models (Ellram and Billington 2001). Between turnkey outsourcing, which exposes the OEM to all the hazards, and in-house procurement, in which the OEM foregoes the potential benefits of outsourcing, are four procurement models that seek a compromise by incorporating various preventive and reactive business controls.

The six models range in means-motive-opportunity (MMO) risk from greatest to least risk (Table 4).

Turnkey

In the turnkey model, the CM negotiates with and buys directly from suppliers. Thus the OEM can use the CM's procurement leverage while keeping procurement overhead low. Also the CM can pool the demand uncertainty of multiple OEMs to reduce the needed levels of raw material inventory. Ideally, this efficiency translates into low costs and high availability.

The turnkey model carries the most MMO hazards of any of the six models, including forfeiture by the OEM of preferential treatment and loss of visibility into true procurement and material costs. For large OEMs and for noncommodity parts, the CM's procurement leverage will probably be weaker than the OEM's. Small OEMs do not automatically benefit either, with some complaining that CMs sometimes fail to "stay on top of pricing and pass those savings on to an individual customer, because they are buying in such huge volumes" (Jorgensen 2004b). In addition, the ability of CMs to obtain high margins on materials procurement may lead them to complacency about reducing manufacturing costs. To avoid some MMO hazards, some OEMs have augmented turnkey procurement with retrospective audits.

Turnkey with Audits

With this approach, the OEM retains the advantages of the turnkey model but adds auditing to detect errors and deter fraud, partially mitigating several hazards of pure turnkey. The OEM may perform the

	Procurement Model	Description	Degree of Hazard Mitigation			Summary of hazard mitigation
Means-motive-opportunity risk faced by OEM	High	Turnkey	CM negotiates with and buys directly from supplier.			All hazards are present. The OEM forfeits preferential treatment.
		Turnkey with audits	OEM audits the transaction prices and quantities in the turnkey relationship.		△	Audits can detect errors and deter fraud. However, OEMs may not discover all problems, or recover all losses, particularly the time value of money.
		Supplier rebates	Supplier sells goods at CM price, and gives rebates to OEM.		△	The tracking and collecting of rebates provides an audit trail. The OEM can mask its preferred prices and retain its relationships with suppliers. However, rebates are difficult to track, and the OEM essentially gives the supplier free loans.
		Buy-sell	OEM buys from supplier at a private price and sells to CM at a higher price.	●	△	The OEM controls operations, prices are masked, and the OEM owns the relationship with the supplier. The OEM can better monitor performance with the resulting timely and accurate information.
		Consignment	OEM buys and owns the inventory, which the CM holds.	●	●	The OEM conducts most procurement activities, reducing the CM's means and opportunities to violate OEM goals. The CM has no incentive to manage inventory properly.
	Low	In-house	OEM buys directly from suppliers, manages storage, and delivers to CMs.	●	●	The OEM has complete control of procurement, which eliminates all MMO risks, but does not take advantage of outsourcing.

Key. ● = hazards are fully mitigated. △ = hazards are partially mitigated.

Table 4: We compare six procurement models based on how effectively they mitigate OEMs' means-motive-opportunity hazards (Table 3). The three-by-three structure of the mitigation column refers to the arrangement of the nine procurement activities (Table 2): The subcolumns represent the three supply chain flows (physical, informational, financial), while the subrows represent the three types of activities (planning, execution, management). In the Turnkey model, the OEM is exposed to all hazards; with the In-house model, the OEM is protected.

audits itself or rely on a specialist firm (Sullivan 2003). Depending on the scope of the audits, the OEM can verify whether the CM respected the supplier volume splits, paid suppliers on time, produced accurate invoices, provided truthful performance data, and shared suppliers' price reductions expeditiously.

Nevertheless, using audits OEMs can discover only a fraction of possible problems, may not gain full recovery, and often lose the time value of money. They still forfeit preferential treatment and lose visibility into true procurement and material costs. In addition,

the OEM bears the cost of the audit. When OEMs believe they have greater procurement leverage than their CMs, they often choose from among the remaining procurement models.

Supplier Rebates

When OEMs believe they can negotiate superior prices and effectively monitor and collect private rebates from suppliers, they can obtain the same partial mitigation as they do with audits, because the information technology systems for tracking and collecting rebates essentially perform implicit and explicit

audits. In addition, suppliers can safely offer the OEM preferential pricing without revealing their prices to CMs and other OEMs. The OEM retains some relationships with the suppliers, preserving a mechanism for the suppliers to report any instances of CMs pressing them for inappropriate concessions. The OEM can easily discover unauthorized parts substitutions because of missing rebates.

The primary disadvantages of supplier rebates are the cost to the OEM for tracking and processing rebates and the costs to suppliers of negotiating prices with both the CM and the OEM. The rebate scheme may be prohibitive for small OEMs and suppliers. Rebates also enhance the supplier's cash-to-cash cycle at the expense of the OEM. The CM still ultimately writes the checks to suppliers and may use this role to enhance its procurement leverage.

The intent of the rebate model can be undermined by collusion between CM and suppliers. The CM and the supplier may agree on an intermediate price, partially bypass the rebate process, and share the OEM's rebate amount. For example, if the OEM price is \$1.00 and the CM price is \$1.10, both the CM and the supplier would be better off at a price of \$1.05. However, by conducting a retrospective audit, the OEM could identify the discrepancy between rebate quantities, CM invoices, and product shipments. Moreover, the supplier would inevitably sacrifice future margins because the CM would leverage this lower price for use with other OEMs currently paying more than \$1.05.

Buy-Sell

With the buy-sell model, the OEM buys directly from the supplier at a private price and immediately resells to the CM at a higher price. In this way, the OEM can outsource tactical purchasing while retaining strategic procurement; once the buy-sell transaction is complete, the supplier delivers the materials to the CM. The buy-sell model is most appropriate when the OEM has greater procurement leverage than does the CM. Some electronics OEMs, including HP, IBM, Motorola, and Dell, and some automotive OEMs have used the buy-sell technique for over a decade (Ellram and Billington 2001; Billington and Kuper 2003; Jorgensen 2003a, b; Shen 2003, *Purchasing* 2003, Carbone 2004, Jorgensen 2004a).

The buy-sell model compares well to supplier rebates in terms of price masking and the benefits of maintaining direct OEM-supplier relationships and provides immediate settlement of price differences. If the masked price is fixed throughout the contract period, the CM obtains stable prices that help it to manage cash flow. This strategy can also provide tax savings, because a multinational OEM can decide where to record the virtual transaction to obtain low tax rates. With buy-sell systems, OEMs can determine supplier volume splits, establish considerate ordering practices, pay suppliers promptly, ensure accurate invoicing and timely deliveries, resolve problems effectively, and obtain reduced prices from suppliers immediately. With timely and accurate information resulting from buy-sell transactions, OEMs can monitor CMs' materials choices and forecasting practices. Finally, by controlling procurement, the adopting OEMs gain influence over investments in support resources.

The primary disadvantages of the buy-sell model for OEMs are the overhead required to manage procurement and any investment in new systems and processes to enable buy-sell execution. In addition to maintaining supplier relationships, the OEMs must replicate the channel functions of a materials reseller. Also, the CM still controls inventories after taking physical possession of them.

Consignment

Consignment is an arrangement in which OEMs buy and own the inventory, which the CMs store. OEMs often use this model for parts that are unique, slow moving, proprietary, or scarce. They can thus mask prices and establish inventory buffers above those prescribed by the CMs' standard policies. With consignment, OEMs are responsible for most of the procurement activities, reducing various risks. Because the OEMs officially own the inventory, CMs cannot readily divert materials to other OEMs.

However, by decoupling inventory ownership and inventory management, the OEMs give CMs no financial motive for avoiding excess inventory. Unless the OEMs link their information systems to their CMs', the OEMs will have difficulty monitoring inventory levels at CM sites and may be surprised by large inventory write-downs when eventually making accurate counts.

In-House

With in-house procurement, OEMs buy directly from suppliers, managing storage and transit to CMs. OEMs began with this approach when they first outsourced production by providing prepackaged part kits to CMs for overflow assembly. The OEM completely controls procurement, which eliminates all MMO risks.

Such control is costly. In-house procurement requires fully staffed organizations, highly integrated information systems, and distributed locations to plan, execute, and manage the inbound supply chain from suppliers to CMs. OEMs must stay abreast of technical developments and in contact with potential suppliers around the world. They must also maintain inventory storage locations (hubs) near the various CM assembly sites. All this investment still may not result in reduced material costs.

Safeguards

OEMs must weigh the disadvantages of lost preferential treatment, potential brand damage, and financial risk against the advantages of reduced costs and overhead. They must base their investment decisions on the magnitude and importance of the various factors, including the nature of the industry, the attributes of the procured materials, the dynamics among the OEM, CM, and suppliers, and the firms' relative sizes and power. To assist procurement managers with this task, we suggest five general principles for mitigating outsourcing risks: an OEM should preserve and strengthen its power, limit the means available to CMs for usurping this power, provide appropriate incentives to motivate CMs, limit CMs' opportunities to exploit their means of violating OEM interests, and establish formal governance processes (Table 5).

Preserving Power

OEMs have kept many outsourcing hazards in check by maintaining the power to call all the shots with their service providers. However, OEMs must guard their power over the supply chain. It is threatened by the trend to outsource functions beyond assembly and procurement, such as product design and logistics. The OEM dilutes its power by transferring such functions, particularly when the outsourced activities are consolidated at a single service provider. OEMs

Principle	Tactic
(1) Preserve Power: Increase relative strength in the supply chain	<ul style="list-style-type: none"> —Install central oversight and coordination of procurement —Clarify obligations and accountability up front —Foster competition among service providers
(2) Address the <i>Means</i> : Revisit the division of labor	<ul style="list-style-type: none"> —Bring some activities back in-house —Avoid granting too many responsibilities to a single service provider
(3) Address the <i>Motive</i> : Align incentives (or at least make them explicit)	<ul style="list-style-type: none"> —Design contract structures to minimize conflicts of interest —Offer appropriate compensation for "bearing the risks" —Develop mutual trust by investing in relationships
(4) Address the <i>Opportunity</i> : Install business controls to improve the management of outsourced activities	<ul style="list-style-type: none"> —Benchmark and model product and supply chain financials —Document actions and record transactions —Monitor on-going performance —Perform periodic or continuous audits
(5) Formalize Governance: Establish processes for improving performance	<ul style="list-style-type: none"> —Create governance councils with authority and cross-functional buy-in —Expediently resolve disputes, enforce penalties, and dispense rewards

Table 5: To assist OEM procurement managers in customizing business controls to meet their companies' needs, we developed five general principles for mitigating outsourcing risks. An OEM should preserve and strengthen its power, limit the means available to CMs for usurping this power, provide appropriate incentives to motivate CMs, limit CMs' opportunities to exploit their means of violating OEM interests, and establish formal governance processes.

are also threatened by their CMs' efforts to establish switching barriers for their customers, often in the form of deep relationships, formalized business processes, and customized information systems. Norberg and Banavige (1999) describe the evolution of these barriers in electronics, where many CMs earn significant revenues from customers that have little or no manufacturing capacity. In many cases, the CMs are the OEMs' primary or sole sources.

To retain purchasing clout, an OEM can centralize and tightly control its internal activities, especially procurement of outsourced services. It can thus prevent its divisions from being played against each other. OEMs can use e-procurement tools, such as reverse auctions, to leverage their purchasing power and accelerate negotiations, while still enhancing

long-term supplier relationships (Ledyard et al. 2002, Hohner et al. 2003, Carbone 2004).

OEMs can diffuse the concentration of outside power by distributing outsourced activities among multiple CMs or other service providers. By itself, doing so is no panacea; the peculiarities of multi-party negotiations sometime give even a bit player disproportionate leverage if it has the swing vote (Lidow 2004). The impact of outsourcing on the balance of power in a supply chain requires further research. Most research on sourcing has focused on the merits of sole sourcing versus multiple sourcing of a single material or service (Elmaghraby 2000), rather than spreading different activities across multiple agents.

Despite the difficulty of covering some aspects of behavior in contracts, OEMs must try to formulate contracts that make their expectations and accountability concrete. Mucha (2002) provides guidance.

Limiting the Means

An OEM can limit the means CMs have to usurp its power by reallocating the decision rights, perhaps by bringing activities back in house. For example, while the objective of collaborative forecasting is to take advantage of all knowledge about future demand, CMs may leak critical information to competitors. Li (2002) suggests that OEMs evaluate information sharing in light of the private information (and its value) that competitors can infer from the actions of mutual suppliers. Fortunately, information sharing is not an all-or-nothing proposition. With current information systems, OEMs can outsource various planning, execution, and management tasks at a much finer degree of granularity, controlling the scope of responsibility tightly and reallocating it easily.

OEMs can also limit the means by distributing duties among multiple parties. Distributed responsibility exposes potential errors to many eyes and increases the effort required to commit fraud, but increases the costs for coordination.

OEMs should develop the ability to execute a variety of procurement approaches and a systematic methodology for deciding how to allocate their spending among them. Most of the 20 OEMs we audited were satisfied with the benefits they obtained by using various models but were not sure they knew

how to select the best one for a particular situation. Billington and Kuper (2003) provide some useful lessons based on HP's experiences. HP uses the buy-sell model for its strategic commodities that are high value or come from key suppliers, that is, the 20 percent of parts representing about half of its production spending. Using this approach, HP typically achieves a return on investment of more than eight-to-one, including setup costs and IT investments. For the next 50 percent of parts, HP uses audits (to verify pricing) and rebates (to mask pricing). HP allows CMs to procure the remaining commodity parts in turnkey fashion.

Motivating CMs

When CMs' agendas conflict with their OEMs', the OEMs should try to align them via the incentives they provide (Narayanan and Raman 2004). OEMs should begin by vetting existing contracts for structural elements that create conflicts of interest. For instance, establishing fixed fees for materials handling might be better than paying CMs a percentage on top of materials costs. In altering these relationships, OEMs must anticipate that CMs may attempt to increase other charges to offset any reductions in procurement earnings.

OEMs can encourage desirable behaviors by attaching rewards to them. For example, if an OEM wants its CM to guarantee supplies and fast turn-around times, the OEM should be willing to pay in advance, pay for order increases, or commit to minimum quantities. Billington et al. (2002) describe how to structure procurement contracts so as to share demand risk among OEMs, CMs, and suppliers. Game theoretic approaches (Cachon and Netessine 2004) may be informative for comparing different incentive alignment mechanisms.

To build ongoing relationships, the parties should establish mutual trust, perhaps through open-book accounting. Over time, they can create an environment in which they uphold obligations to preserve the mutually beneficial relationship, not to avoid litigation. Canon and Hewlett-Packard's supply partnership for over 20 years is an archetype of such a relationship (Lewis 1999). Indeed, the contract (which may be simply a short statement of intent) becomes a framework for keeping the relationship sane and

stable, not a vehicle for imposing control. Taylor and Plambeck (2003) delineate the benefits of ongoing relationships when uncertainty or the costs of enforcement limit the value of formal contracts.

Limiting CMs' Opportunities

OEMs can redesign processes to limit CMs' opportunities to violate OEM intentions. This entails careful attention to the rules of engagement, information systems, and monitoring procedures. Because OEMs' information systems are often not linked with their CMs', transactions are not always documented. With information systems that record such activities and automatically check quantities supplied, services performed, and funds exchanged, firms can jointly manage exceptions. For example, an invoice without a receipt may indicate the creation of a fictitious supplier, while a receipt without an invoice could signal that goods have been obtained illegally.

OEMs can facilitate their management of suppliers' and CMs' performance by creating metrics that predict downstream performance, minimize information requirements, and are easy to monitor. Beyond electronic monitoring, OEMs can conduct periodic human-based audits of information from multiple systems to discover subtle forms of error or fraud. They can also use insights from such audits to modify policies, procedures, and systems to prevent recurrences and to develop reward and penalty schemes to align incentives.

Formalizing Governance Processes

Rather than expecting their procurement organizations to police suppliers and service providers, OEMs should embed governance processes in a formal structure, give procurement personnel authority, and obtain cross-functional approval. Large OEMs, such as IBM and HP, have long maintained commodity councils to direct strategic sourcing and liaisons with component suppliers and CMs (Morgan 2003, Carbone 2004). These councils usually consist of executive sponsors, and representatives from procurement, research and development, marketing, legal, and operating units. For instance, instead of merely demanding price concessions, Chrysler established teams to work with suppliers to identify, prioritize,

and implement methods of achieving mutual savings. This resulted in supply-chain savings of over \$2 billion in 1998 (Hartley et al. 2002).

Commodity councils also institutionalize a mechanism for resolving disputes, providing incentives, and imposing penalties on parties at fault (which can include the OEM). These penalties can include reprimands or terminations of employees, fines for suppliers, cancellation of contracts, elimination of future work, or disparagement of vendors.

Conclusion

OEMs in all industries will continue to outsource production functions, especially as service providers grow in size and capability. However, OEMs must carefully consider the CMs' underlying means, motives, and opportunities when deciding what and how to outsource. Only by investing in processes and information systems to manage CMs and prevent abuses of the relationship can OEMs safeguard the promise of production outsourcing.

Recent corporate scandals should provide a sobering warning. Despite longstanding internal control schemes, some executives have enriched themselves by exploiting accounting loopholes and gaps. The resulting shareholder outrage led to increased legal and regulatory scrutiny, including the Sarbanes-Oxley Act. But with production outsourcing becoming widespread only over the last decade, what external business controls exist? If a company's service providers cause shareholder losses, will the company's managers be found negligent if they did not anticipate or prevent such misbehavior? Beyond Sarbanes-Oxley, companies must rethink corporate governance in a highly outsourced economy.

Acknowledgments

We thank Joseph Sandor, former director of purchasing at Sara Lee, for his articulation of the strategic goal of procurement (creation and preservation of preferential treatment). We also acknowledge Charles Holloway of Stanford University and Bill Boller, retired vice president of worldwide order fulfillment and manufacturing at Agilent Technologies, for their insights regarding the strengths and weaknesses of the various procurement paradigms. We appreciate the efforts of the editorial team at *Interfaces*, which greatly improved the quality of our exposition.

References

- Bahli, Bouchaib, Suzanne Rivard. 2003. The information technology outsourcing risk: A transaction cost and agency theory-based perspective. *J. Information Tech.* **18**(3) 211–222.
- Barthelemy, Jerome. 2003. The seven deadly sins of outsourcing. *Acad. Management Executive* **17**(2) 87–100.
- Billington, Corey, Andre Kuper. 2003. Trends in procurement: A perspective. A. Wharton, ed. *Achieving Supply Chain Excellence Through Technology*, Vol. 5. Montgomery Research, Inc., San Francisco, CA.
- Billington, Corey, Blake Johnson, Alex Triantis. 2002. A real options perspective on supply chain management in high technology. *J. Appl. Corporate Finance* **15**(2) 32–43.
- Cachon, Gerard P. 2003. Supply chain coordination with contracts. S. Graves, T. de Kok, eds. *Handbooks in Operations Research and Management Science: Supply Chain Management*. North-Holland, Amsterdam, The Netherlands.
- Cachon, Gerard P., Serguei Netessine. 2004. Game theory in supply chain analysis. David Simchi-Levi, S. David Wu, Zuo-Jun (Max) Shen, eds. *Handbook of Quantitative Supply Chain Analysis*. Kluwer Academic Publishers, Norwell, MA.
- Carbone, James. 2004. Hewlett-Packard wins for the 2nd time. *Purchasing Magazine* **133**(14) 34–50.
- Doig, Stephen J., Ronald C. Ritter, Kurt Speckhals, Daniel Woolson. 2001. Has outsourcing gone too far? *McKinsey Quart.* (4) 25–37.
- Earl, Michael J. 1996. The risks of outsourcing IT. *Sloan Management Rev.* **37**(3) 26–32.
- Eccles, Robert G., Harrison C. White. 1988. Price and authority in inter-profit-center transactions. *Amer. J. Sociology* **94** (Supplement: Organizations and institutions: Sociological and economic approaches to the analysis of social structure) S17–S51.
- Eisenhardt, Kathleen M. 1989. Agency theory: An assessment and review. *Acad. Management Rev.* **14**(1) 57–74.
- Ellram, Lisa, Corey Billington. 2001. Purchasing leverage considerations in the outsourcing decision. *Eur. J. Purchasing Supply Management* **7**(1) 15–27.
- Elmaghraby, Wedad J. 2000. Supply contract competition and sourcing policies. *Manufacturing Service Oper. Management* **2**(4) 350–371.
- Hargadon, Andrew, Robert I. Sutton. 2000. Building an innovation factory. *Harvard Bus. Rev.* (May–June) 157–166.
- Hartley, Janet L., Bertie M. Greer, Seungwook Park. 2002. Chrysler leverages its suppliers' improvement suggestions. *Interfaces* **32**(4) 20–27.
- Hohner, Gail, John Rich, Ed Ng, Grant Reid, Andrew J. Davenport, Jayant R. Kalagnanam, Ho Soo Lee, Chae An. 2003. Combinatorial and quantity-discount procurement auctions benefit Mars, Incorporated and its suppliers. *Interfaces* **33**(1) 23–35.
- Jorgensen, Barbara. 2003a. Motorola to hide pricing. *ElectronicNews.com*, November 3. Retrieved January 16, 2006 <http://www.reed-electronics.com/electronicnews/article/CA333610.html>.
- Jorgensen, Barbara. 2003b. Back to the future. *Electronic Bus.* **29**(15) 42.
- Jorgensen, Barbara. 2004a. One step at a time. *Electronic Bus.* **30**(4) 38.
- Jorgensen, Barbara. 2004b. When outsourcing isn't the answer. *Electronic Bus.* **30**(9) 39–40.
- Lakenan, Bill, Darren Boyd, Ed Frey. 2001. Why Cisco fell: Outsourcing and its perils. *Strategy Business* **Q3**(24) 1–12.
- Ledyard, John O., Mark Olson, David Porter, Joseph A. Swanson, David P. Torma. 2002. The first use of a combined-value auction for transportation services. *Interfaces* **32**(5) 4–12.
- Lee, Hau L., Corey Billington. 1992. Managing supply chain inventory: Pitfalls and opportunities. *Sloan Management Rev.* **33**(3) 65–73.
- Lee, Hau L., V. Padmanabhan, Seungjin Whang. 1997. The bullwhip effect in supply chains. *Sloan Management Rev.* **38**(3) 93–102.
- Lewis, Jordan D. 1999. *Trusted Partners: How Companies Build Mutual Trust and Win Together*. Free Press, New York.
- Li, Lode. 2002. Information sharing in a supply chain with horizontal competition. *Management Sci.* **48**(9) 1196–1212.
- Lidow, Derek. 2004. Perspective: Mastering supply chain politics. *CommsDesign.com*, April 1. Retrieved January 16, 2006 <http://www.commsdesign.com/showArticle.jhtml?articleID=18600479>.
- Linder, Jane C. 2004. Transformational outsourcing. *Sloan Management Rev.* **45**(2) 52–58.
- Logan, Mary S. 2000. Using agency theory to design successful outsourcing relationships. *Internat. J. Logist. Management* **11**(2) 21–32.
- Morgan, Jim. 2003. R. Gene Richter: The man who made supply strategies work. *Purchasing* **132**(17) 45–50.
- Mucha, Susan. 2002. EMS contracts: More than a handshake. *Circuits Assembly* (August) 42–46.
- Narayanan, V. G., Ananth Raman. 2004. Aligning incentives in supply chains. *Harvard Bus. Rev.* (November) 2–9.
- Norberg, Roger W., Joseph M. Banavige. 1999. Electronics manufacturing supply chain. Investment report, US Bancorp, Piper Jaffray, New York.
- Prahalad, C. K., Gary Hamel. 1990. The core competence of the corporation. *Harvard Bus. Rev.* (May–June) 79–90.
- Purchasing. 2003. OEMs should outsource, but maintain control of sourcing. *Purchasing* **132**(19) 56.
- Quinn, James Brian, Frederick G. Hilmer. 1994. Strategic outsourcing. *Sloan Management Rev.* **35**(4) 43–55.
- Shen, Steve. 2003. Dell aims to establish a new model for notebook procurement. *Digitimes.com*, December 1. Retrieved January 16, 2006 <http://www.digitimes.com/NewsShow/Article.asp?datePublish=2003/12/01&pages=A1&seq=1>.
- Sullivan, Laurie. 2003. Outsourcing's hidden costs. *EBNonline.com*, October 6. Retrieved January 16, 2006 <http://www.my-esm.com/showArticle.jhtml?articleID=15201550>.
- Taylor, Terry A., Erica L. Plambeck. 2003. Supply chain relationships and contracts: The impact of repeated interaction on capacity investment and procurement. Stanford GSB Research Paper 1813, Stanford University, Stanford, CA.
- Thurm, Scott. 2003. Flextronics must pay damages. *The Wall Street J.* (September 25) B1.
- Tsay, Andy A., Steven Nahmias, Narendra Agrawal. 1998. Modeling supply chain contracts: A review. S. Tayur, R. Ganeshan, M. Magazine, eds. *Quantitative Models for Supply Chain Management*. Kluwer, Boston, MA, 299–336.