Implications of Technological Advances in Information Systems for Multinational Corporate Strategic Decision-Making

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Task Force on

International Trade Ramifications of the Impact of Information Systems, Artificial Intelligence, and Robotics on Multinational Organizations

by

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Abstract

Technological advances in information systems allow global firms to reduce their total costs by using lowest-cost suppliers, lowest-cost production facilities, and lowest-cost systems of logistics. As global firms reconfigure their organizations to exploit these opportunities, they will change their traditional trading relationships due to (1) changes in coordination of value-creating activities among geographically-distant facilities, (2) changes in capital asset locations, (3) changes in buyer-supplier relationships, and (4) changes in the use of strategic alliances to supplement firms' internal capabilities.

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Except for retailing and other decidedly-local business activities, most industries have developed (or are evolving to) global traits. Because of this change, strategic management has by necessity become more complex. Strategic management within global industries now involves decisions concerning management of multi-site operations in different economies rather than those of a firm operating within one sheltered economy. Because of this change, global strategic management requires analytical capabilities (and tools) of greater sophistication than those used by firms facing strategic alternatives that are relatively limited.

As I explain in this paper, technological advances in information systems, artificial intelligence, and robotics have assisted managers in their task of formulating and implementing an effective global strategy. Through information system improvements, global firms have exploited opportunities to use the lowest-cost suppliers, lowest-cost production facilities, and lowest-cost systems of logistics. But effective use of these technologies has required organizational changes that disrupt firms' traditional trading patterns. Changes in the locations of certain value-adding activities and relationship changes among the subsidiaries that performed those tasks have allowed firms to make new economics trade-offs regarding the mix of value-adding activities performed

in-house. The net result of these make-or-buy, activity location, and standardization decisions has been a revitalization of competitive vigor in the 70 percent (or more) of all industries in Japan, Western Europe, and the United States that are facing maturity -- slow growth, no growth, or negative growth in industry-wide unit shipments. In such industries, where product quality and supporting service offerings have become of increasing importance, technological advances in information systems, artificial intelligence, and robotics have allowed firms to shorten the feedback loop associated with tracking market changes and adapting operations to each market's new competitive success requirements. Briefly, although competition in these maturing and global industries has become increasingly more difficult, some firms have adapted well to these competitive challenges by embracing the new capabilities created by technological advances in information systems. As these adaptive firms change their strategic approaches and mix of globally-coordinated activities, it has been necessary for their suppliers and distributors also to develop new capabilities. Their resulting trading relationships have changed in terms of (1) innovational content, (2) flexibility regarding task performance, and (3) performance measures, as well as in terms of the more obvious changes in (4) geographic shipping patterns, (5) plant locations, and (6) revenue flows).

Within young global industries -- those where industry-wide shipments are still growing at increasing rates -- technological advances in information systems, artificial intelligence, and robotics have accelerated the pace of change. Trading patterns among many firms within such global industries have been altered through a greater use of joint

ventures and other forms of strategic alliances as multinational firms scurry to configure themselves in the most advantageous relationships with other firms.

Global Strategy for Global Markets

In order to illustrate how technological advances have changed the nature of corporate strategic decision making within multinational firms, it is necessary to explain key concepts concerning global strategy. The challenge of formulating and implementing global strategy has received increasing attention from scholars of strategic management recently because it is different along many important dimensions from strategy within a single economy. The most important difference in competing globally -- and the reason that technological advances in information systems, artificial intelligence, and robotics are of such great importance to global firms -- arises from the evolution of formerly-distinct international markets into increasingly-similar, hence global, markets and from firms' efforts to serve those global markets with standardized products (or resources).

The Development of Global Markets

Global markets developed because the demands of customers in many geographic markets have become increasingly similar while customer purchasing power has risen in several more countries. Changes in other forces have also reinforced the need for a global strategy to coordinate a multinational firm's global operations. For example, products

representing higher units of value-added per unit of weight have made transnational shipping arrangements economically feasible. Tariff barriers to trade have been weakened by GATT agreements. Transportation costs have declined through improvements in shipping and packaging technologies (Doz, 1978; Gluck, 1983).

Multidomestic versus global markets. Before the effects of these forces converged to make globally-coordinated strategies a necessity, many decisions within multinational firms affecting geographically-distinct operations could be made independently of each other. Regional operating autonomy was justified when customer needs in various international markets were so significantly different from each other that each country (or region) could be treated like a separate organizational entity. During this era, multinational firms (i.e., firms that operated in several countries) could be considered to be agglomerations of businesses -- rather like firms pursuing the diversification strategy of being a "holding" company. Briefly, such markets were "multidomestic" rather than global because products developed to satisfy regional customers truly could not be interchanged with those developed for other regions with ease, and because the divisions serving multidomestic markets often controlled their own respective stand-alone facilities that were capable of performing all value-adding tasks needed to serve a specific geographic market on their own (Doz, 1978).

Standardization strategies. By contrast, competition in global markets calls for globally-coordinated activities. Global firms must participate in all key markets -- through out the globe -- as each

critical mass of customers becomes important to strategies of product (and resource) standardization. Briefly, differences are reduced in products offered to various customers (or in the way that products or services are provided to customers in diverse locations) in order to gain scale economies. Each incremental group of customers that will accept the multinational firm's standardized product (or resource) solution increases the potential cost reductions available through economies of scale.

Normative Strategies for Global Markets

For firms that had previously operated in "sheltered" domestic markets, the evolution to global markets meant that: (1) demand could be satisfied with a standardized product, (2) stimuli for product, process, or merchandizing innovations could originate in many geographic markets, (3) the infrastructure created by local subsidiaries of global firms could disseminate product innovations quickly, and (4) coordination of international logistics within a firm's value chain would become more complex (Harrigan, 1984; Vernon, 1979). Depending upon whether multinational firms chose to provide superior <u>value</u> to customers by adapting products to regional idiosyncracies or achieve superior <u>cost</u> performance by standardizing products and selling only to the customers who will accept that product configuration, global strategy meant designing a marketing system that provided the broadest coverage of world markets that was consistent with the strategic posture chosen. The need to transfer new technologies quickly to worldwide subsidiaries created

pressures to increase coordination among multinational firms' subsidiaries.

When multinational firms pursue product (or resource) standardization strategies by competing in global markets, they must also adjust their activity location decisions to be capable of using the lowest-cost suppliers, lowest-cost production facilities, and lowest-cost system of logistics in serving their customers by moving activities to exploit windows of opportunity in factor costs. They must also be capable of adapting the most suitable technologies, and of working with their suppliers, distributors, and industrial customers to incorporate meaningful innovations as changes occur.

Belief in this contingency approach to strategy is so strong that it is believed that multinational firms that do not make the transition from multidomestic to global operations when the markets they serve become global are doomed to long-term strategic failure (Doz, 1978; 1980; 1985; 1987; Gluck, 1983; Keegan, 1979; Kiechel, 1981; Lehnerd, 1987; Leontiades, 1985; Magaziner, & Reich, 1982; Mascarenhas, 1984; Porter, 1987; Walters, 1986). There is a similar (and strong) belief that firms cannot afford to confine their marketing activities to only one national economy; the leading firms in each global industry will pursue global strategies while their nonglobal competitors will shrink in relative importance and prosperity.

Triad market entry. Under this fatalistic view of global markets, multinational firms pursuing global strategies enjoy little strategic

choice with regard to decisions about which markets to enter; belief in "triad power" makes ultimate entry into Japan, Western Europe, and the United States a necessity (Ohmae, 1985). After the corners of the strategic triad are secured, global managers enjoy limited discretion with regard to which secondary markets to enter (and when to enter them). As with any effectively-implemented marketing strategy, entering the right markets in the right way is believed to be of paramount importance to competitive success for global firms (Kotler & Fahey, 1982; Root, 1987). Late entry -- buttressed by careful market research studies of pioneering firms' experiences, a continuing stream of new product features, high product reliability, and high after-sale service -- was regarded as being a less risky entry strategy for global firms seeking scale economies through product (and resource) standardization than is early market entry and costly product pioneering.

The Global Strategy Response

Global product strategies require multinational firms to determine which components of a product are to be intentionally uniform and cross-sourced, and which components are to be intentionally tailored to the needs of local markets (Magaziner & Reich, 1982). If strategic choices in global competition involve finding and exploiting the economic leverage points of a business, it is inevitable that multinational firms will quickly reach relative parity with respect to the easy strategic decision. Given that all surviving multinational firms will engage in triad market entry and globally-coordinated marketing activities, the greatest opportunities remaining for creative global strategies will be

on the manufacturing and organizational battlefronts. Thus, the longer an industry is global, the more likely that the important choices in global strategy will entail identifying (1) which technology (regardless of its source) offers promise for the greatest number of markets, (2) which product design can be marketed in the maximum number of countries or adapted most easily to slightly-differing country requirements, and (3) which source offers the best trade-off between quality and labor costs (Gluck, 1983).

Most multinational firms saw merit in adopting a global strategy. For firms with products requiring massive R&D investments, access to international customers became necessary to amortize investments and realize scale and experience curve economies. Even for firms with "low-technology" products like automobiles, the evolution to global markets suggested opportunities for (1) minimizing the number of components that make up a car, (2) standardizing the components used in different models of car, (3) designing models of car that would sell in many countries, and (4) striving for maximum volume to realize scale and experience economies (Gluck, 1983).

Information Systems for Global Strategies

Technological advances in information systems -- the (1) management systems that provide both real-time and comparative facts used to guide managerial decision-making, (2) configurations of telecommunications links used to convey information, (3) strategy that is operationalized by organizational reporting and decision-making relationships, and (4)

hardware and software used in information systems -- have been helpful in operationalizing strategies that recognize the increasing similarities in customers' demands within global markets. In particular, "group technology" systems -- the practice of classifying (or coding) a product part according to size, shape, function, and other pertinent parameters and tracking such product parts through databases (Predicasts, 1983) are especially consistent with the practice of standardizating component parts for global products. Because global products are designed to be sold by many different country subsidiaries, the components comprising such products can be standardized and group technology can be used in their manufacture to obtain the lowest-cost inputs. Savings in group technology systems also result form lower inventorying costs, learning curve economics based on designs of older products, and scope economies.

Global quality and servicing capacities. Ultimately, the efficacy of each firm's global strategy can be assessed by how well it meets the competitive challenges of remaining (1) cost competitive while also providing (2) superior product quality and supporting service. To the extent that the means of attaining these goals has sometimes been in conflict, technological advances in information systems, artificial intelligence, and robotics have offered multinational firms a way to continually lower costs while also reducing variability in the design process, technical documentation, make-or-buy sourcing, manufacturing, inspection, shipping, installation, servicing, and repair maintenance activities. When multinational firms exploit the technological advances in information systems, artificial intelligence, and robotics for such total quality control, they can be of greater service to their customers

by better anticipating key accounts' changing product needs and adapting their operations in ways that add greater value to customers' transactions with them.

Critical to attaining the strategic flexibility needed to render such service levels is the ability to apply technological advances in information systems, artificial intelligence, and robotics to the creation of flexible manufacturing systems. Briefly, "flexible manufacturing systems" use machinery that can be changed easily to permit changes in manufacturing processes. Flexible manufacturing systems consist of (1) computer-controlled machining centers that sculpt complicated metal parts at high speed and with great reliability, (2) robots that handle the parts, and (3) remotely guided carts that deliver materials. The components of a flexible manufacturing system are linked by electronic controls that dictate what will happen at each stage of the manufacturing sequence, even automatically replacing worn-out or broken drill bits and other implements (Bylinsky, 1983).

Competitive advantage in using "computer integrated manufacturing" systems revolves around facilitating effective communications among the various pieces of manufacturing automation (Predicasts, 1983) -- from the host computer containing production schedules, group technology part numbers and inventory levels, and other instructions to the microcomputer terminals in worldwide subsidiaries that provide product requests based on market research studies. Competitive advantage in using "computer integrated global strategic management" systems revolves around creating an effective interface between competitive success requirements in the

global markets where a multinational firm operates and the computer-integrated systems it uses for technology creation, manufacturing, and marketing. The management systems that blend such capital assets, databases, and competitive experience must provide multinational firms with scanning capabilities and logistics sufficient to be highly-flexible in the face of competitive environments that cry out for greater coordination of intrafirm activities. To do so, intelligence must quickly be translated into action.

Because firms from every industrialized (and industrializing) economy will be competing for many of the same customers as markets become global, it will not be enough to have high product quality, high flexibility to increase value added through attentive servicing, and excellent logistics. Effective global strategies must also attain continual improvements in costs.

The search for lowest unit costs. Global production strategies involve decisions regarding (1) make-or-buy relationships, (2) value-chain activities, and (3) site location and coordination relationships. ("Coordination" means the sharing and use, by different facilities, of information and other resources.) Like heavily-coordinated global marketing strategies, heavily-coordinated global production strategies result in extensive transshipments of components and finished products between subsidiaries located in different countries. Well-designed management systems using factory automation will enhance multinational firms' capabilities in these highly-coordinated (or interconnected) activities.

Because global markets open up most of the world as candidates for make-or-buy strategies, worldwide sourcing becomes a skill that can provide a competitive advantage when firms recognize that every component used in products sold to their ultimate customers could be purchased from the best vendor -- wherever the best trade-off between quality and labor costs may be found. In global value-chain strategies, modularization decisions -- choosing which high value-added components to make in a centralized plant for subsequent assembly in decentralized plants -- are also a critical part of global production strategy, and global management systems must support these decisions.

Enhanced logistic capabilities. The global manufacturing strategy embraced in a particular industry depends on the nature of key product and market traits. In global coordination strategies, plant locations and the product lines manufactured in each plant are determined by trade-offs regarding shipping costs and technological scale economies. Because multidomestic plants tend to have a smaller technological scale than globally-coordinated plants global firms often substitute several, smaller-scale plants for few, larger-scale plants when using a multidomestic production strategy. The management system guiding this decision must scan how product and customer traits are evolving in key markets to suggest when a transition from multidomestic production to global coordination is appropriate. The global firm's management systems must also suggest when changes regarding which component modules are self-manufactured and where are needed (as well as which modules will be entrustd to vendors). Finally, computer integrated global strategic

management systems must suggest appropriate manufacturing technology strategies.

Many U.S. firms have lost sales to European and Japanese firms by failing to be sufficiently flexible in their dealings with newly-industrializing countries. Strategic flexibility involves a willingness to do many things to win a sale, including (1) giving up control of significant parts of the value chain of activities, (2) abiding by local content requirements, and (3) satisfying government officials in negotiations concerning technical assistance, export requirements, financing, and reinvestment of profits in the host country.

The Global Strategy Dilemma

In many U.S. firms, lower profit margins have traditionally justified making a narrower range of standardized product designs. This strategy has resulted in less manufacturing flexibility because its emphasis on "hard" automation -- the Detroit-style inflexible systems that stamped out look-alike parts in huge volume (Bylinsky, 1983) -- was driven by pursuit of scale economies. Emphasis on scale economies occurred when technologies became so mature and customers became so sophisticated that firms' profit margins could no longer justify investments in a flow of process innovations while also satisfying the short term-oriented demands of financial investors. Under the logic that sensitivity to the demands of "twenty-minute shareholders" imposes, production systems had to emphasize lower unit costs more heavily than high manufacturing flexibility. The logical result of emphasis upon

making a more predictable set of standardized products (with lower unit costs) was often large-scale, automated factories with highly-specialized equipment and workforce, centralized coordination of operations, and heavy intrafirm transfers of components.

This chain of events creates a strategic dilemma. When customers are growing ever more sophisticated, hence demanding, they become less willing to accept firms' standardized product solutions to their needs. When customers receive the greater product customization they demand, standardization strategies become less viable because satisfying customers' requests makes the demand traits of diverse markets become more fragmented rather than standardized. The evolution away from acceptance of product standardization is antithetical to the needs of vendors who have invested in highly-inflexible assets. Yet they are prevented from investing in the slack resources that would be necessary to serve fragmenting markets by their need to show investors improving performance.

Increased strategic flexibility. Firms that enjoy high profit margins can justify making a wide range of diverse product designs and enjoy assets that offer high manufacturing flexibility. Indeed, maintaining technological flexibility is almost mandatory for firms that must serve high-income markets with a flow of new (often unique), high-performance and high-technology products -- engineering plastics and biogenetics, for example. Such firms require manufacturing systems that are sufficiently flexible to accomodate frequent changes in products as well as rapid market introductions (Stobaugh & Telesio, 1983). Volume flexibility is important for their competitive success because accurate

sales projections are difficult to make. Manufacturing costs -- including the costs of highly-skilled labor -- are not of primary importance for such firms because the product itself is the major competitive weapon, but good communications with (and swift response to) changing market conditions is critical for their competitive success.

Trade-offs. Advances in information systems based on strategies of flexible automation offer the greatest potential for manufacturing goods cheaply in small volumes. The economics of such investments require global firms to balance investors' demands for instant gratification against the changing requirements of remaining viable as a global competitor. Highly flexible plants incur high fixed engineering costs because machines are designed for quick and easy changeover of fixtures, dies, and other tooling. The resulting quick setup fixed costs are high, but low variable labor costs result in performing setups for changing part numbers. In theory, advances in flexible automation can make the economies realized at massive volumes on less flexible manufacturing systems ("scale economies") available in small batches or even single units ("scope economies"). Cost reductions comparable to those available from highly-specialized manufacturing systems arise from policies that do not require machines dedicated to a single task to be either rebuilt or replaced at the time of product change. Instead, when flexible manufacturing systems -- which can be used to make a variety of products on the same line -- are linked with computerized design centers, global firms enjoy the potential to schedule the same production activities in any one of several worldwide locations with total costs comparable to highly-specialized manufacturing systems. Taken it an extreme, flexible

manufacturing systems have the potential to provide a different and far more efficient organization of the global manufacturing process, if organizational power is reapportioned in a manner consistent with the demands of effective global competition (Bylinsky, 1983).

Changes in Corporate Strategic Decision Making

Technological advances in information systems, artificial intelligence, and robotics give multinational firms greater flexibility. Technology is available to support a coordinated, worldwide system of standardized products made from standardized components obtained from the lowest-cost vendor and transshipped to the next stage of processing if multinational firms wish to do so. In some industries, however, a firm's global manufacturing strategies could involve the coordinating of plants intentionally that may not make similar products. This capability is desirable because proper coordination of such plants could yield low unit costs while preserving some of the product diversity necessary to serve each local market effectively (Flaherty, 1987). Technological advances in information systems make it possible to "fine-tune" and adjust firms' balances between highly-standardized and -customized strategic approaches. With such enhanced capabilities, multinational firms are freed from the need to place monolithic factories in the "best" sites and design logistical systems to minimize transshipment costs. With such technological capabilities, only federal governments' demands for second-source vendors of components critical to the national defense, for local content to attain national goals concerning economic growth, trade balances, access to hard currencies, employment, et cetera, and for

other concessions will place restraints on firms' abilities and strategic flexibility to design global organizations with responsive management systems.

Less Emphasis on Locating Plants in Low-Wage Economies

United States firms have been criticized for being overly reliant on the low labor costs available in developing countries and for allowing such cost considerations to dictate the critical mass location of labor-intensive manufacturing activities (Magaziner & Reich, 1982). This fault has been particularly true of the clothing, consumer electronics, metal-working, and electrical equipment industries where management system inefficiencies often offset any cost advantages that were attained.

Unforeseen difficulties. Many multinational firms have discovered that reliance on suppliers with a low labor cost, offshore manufacturing base often generates hidden costs -- increased problems in quality control, higher levels of in-process inventory, and slower response time for coordination between absentee designers and manufacturing operations, or between sales representatives in the field and the offshore factory. By moving the bulk of these labor-intensive manufacturing activities overseas and closing down domestic operations, U.S. firms have discovered that they lose opportunities to compare production costs across plants -- especially across newly-automated plants. Firms that depend on low-wage labor have discovered that they are, in fact, using it as a substitute for new investments in process engineering. With time, such firms have

discovered that they lose any engineering edge they may once have possessed. Moreover, U.S. firms without a domestic manufacturing base that allow overseas, low-wage workers to create knowledge on the plant floor have found it difficult (if not impossible) to repatriate that know-how to domestic operations after they have closed their U.S. plants, particularly where innovative factory employees in low-wage countries take their undocumented know-how with them when changing employers.

Multinational firms are discovering that the attractiveness of non-automated, lower-cost labor sites fades when similar total unit costs can be attained using flexible manufacturing systems. As the economics of flexible manufacturing systems undermines the attractiveness of substituting low-cost labor for capital investments, some multinational firms are changing their global plant location schemes.

Technological advances in information systems, artificial intelligence, and robotics are affecting multinational firms' future global plant location decisions by allowing firms to replace their low-cost labor forces with the higher-cost (and irreversible) capital assets of flexible manufacturing systems. In particular, the increasing greater importance of customer service as a part of the total product offering is expected to encourage multinational firms to move closer to their ultimate customers in environments where product quality is moot, especially where customization and supporting services have become critical sources of product differentiation. As an additional benefit, multinational firms are discovering that reducing dependence on plants with low-cost labor eases related global coordination problems. Briefly, when multinational firms based within mature economies who sought lower labor costs

acceded to host government demands for investments in hard currency-producing plants, they discovered that they were obliged to find ways to accommodate the excess capacity created by the plants they had erected in newly-emerging nations.

Fewer Imports of Raw Materials and Components

Where capital assets have been moved closer to ultimate customers, reductions in imports of raw materials and components will likely occur if local vendors develop capabilities that compare favorably with off-shore vendors. Technological advances in information systems enable multinational firms to track variability in suppliers' shipments and suggest processing improvements that would improve key vendors' capabilities. Firms' preferences for using well-established vendors often result in those firms for which multinational firms have the best information making matching investments in the same countries where key customers have established facilities.

Thus technological advances in information systems, artificial intelligence, and robotics are likely to result in a tighter bonding of parties to the buyer-supplier relationship. Greater interconnection of design processes, inventory controls, delivery systems, and other service-content aspects of the total product offering is likely to evolve between buyer and supplier as they truly become extensions of each other's corporate entity.

Greater Use of Joint Ventures

Changes in the skills needed to survive in firms' competitive environments -- due to the accelerating pace of technological change and the broader range of technological capabilities firms must possess -- have made the use of strategic alliances a necessity, especially within industries where proficiencies in data-processing and telecommunications are demanded by customers but possessed by no single vendor and where buyers and suppliers must work together to design new products. Although revenue flows associated with the licensing of technologies may increase as a result of such collaborations, fewer technological routes will coexist in cases where formal agreements to cross-manufacture outputs exist.

Greater use of joint ventures and other forms of strategic alliance will coincide with a critical structural change on the fringes of global industries. While leading firms who pursue strategies that heavily emphasize standardization and scale economies will continue to control as many aspects of their global operating systems in-house, smaller players will retreat in their activity scope to emphasize what they do best. Their resulting greater specialization will be accompanied by a greater use of cross-development, cross-manufacturing, and cross-distribution ventures among firms that were previously considered to be competitors. The greater complexity introduced by such networks of cooperation will make the support of technologically-advanced information systems a necessity.

The investments needed to enable firms to be global players carry very long payback periods. As much, they may not be attractive to firms that must satisfy pressures for continual sales growth -- even when their internal research efforts have failed to yield the revolutionary new products needed to supplant existing products. The investments in information systems needed to support global strategies may similarly be unattractive to multidomestic multinational firms which operate under short term cash constraints. Nevertheless, development of these supporting systems is crucial to maintaining strategic flexibility in evolving global environments, such as those described herein. For firms without the patient capital needed to stake out a global position alone, joint ventures will allow firms to accelerate the introduction of pioneering products. Combinations like the NEC-Honeywell-Bull joint venture give customers broader product choices at lower risk to their developers. Joint ventures or other forms of cooperation to share information systems may represent another useful business arrangement to circumvent the short term orientation that could otherwise resource constrained multinational firms.

Summary

1. Flexible manufacturing systems will enhance the flexibility of coordinating related (or interconnected) activities that are typically performed in-house by global firms.

2. Replacement of low-cost labor with higher-cost (and irreversible) capital assets will encourage moves to sites that are closer to customers. Proximity to customers will become preferred where product quality is moot. Customization and supporting services will then become sources of differentiation among global competitors.

3. Location of capital assets near customers will reduce imports of finished product. When nearby suppliers become qualified, imports of supplying products will also decrease. Suppliers will form networks with customers and quasi-integrated relationships will evolve.

4. Joint ventures and other forms of cooperation will reverse flows associated with licensing revenues. Development of one partner's technological standards may have to be sacrificed in preference of the other partner's design for the venture to attain scale economies.

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