LOGISTICS INFORMATION SYSTEMS IN A
JUST-IN-TIME ENVIRONMENT

by
James H. Bookbinder
and
David M. Dilts
University of Waterloo

HEADNOTE

One usually thinks of logistics as an "outbound" activity, e.g., the physical distribution of finished products from factory to warehouse to retailer. A firm's Logistics Information System (LIS) would thus generally be designed to support these outbound shipments. However, when a customer's inbound physical supply is operated in a Just-in-Time (JIT) manner, different needs and expectations are imposed on both the customer's and the supplier's LIS. In this article a method is suggested in which a firm might design and operate its LIS in light of the preceding expectations. A conceptual model of a JIT-LIS is presented, as well as specific suggestions for the implementation of the model in the automotive industry.

INTRODUCTION

Many authors have addressed the impact on manufacturing of the Just-in-Time (JIT) philosophy (see e.g., Schonberger). Major manufacturing industries, such as automotive and electronics, have for several years insisted on reduced but reliable inventories of raw materials, components and work-in-process by using this philosophy. Those firms which supply these industries with components and sub-assemblies have been forced to "go the line" with regard to delivery times and quality levels. Shipments must be made within narrow time windows which are rigidly enforced. Quality standards have also increased, since in a JIT environment, there is little or no margin for defective items. Virtually every component must be delivered on time and must be 100% good quality.

The majority of studies on JIT have concerned the "inbound" side of distribution. From the point of view of the manufacturer, JIT deliveries are inbound shipments of materials. Most writers have thus chosen their vantage point to be that of the assembler of final product, and have usually concentrated on a few management functions. For example, Hill and Schonberger considered the control of inbound supplies and other inventories in a JIT system. Hill and Vollmann discussed the management of inbound transportation.

Naturally, these same deliveries to the final assembly plant are "outbound" from the respective suppliers, and of course the manufactured end-items must pass through a distribution system. Bookbinder and Locke analyzed distribution of final products in a JIT environment in which little inventory would be held at intermediate echelons (warehouses). Instead, these sites would serve to "break bulk" and mix deliveries from various plants, and then deliver onward to the final stock-keeping locations. An excellent information system would be required in order for the warehouses to function in this "stockless" manner.

It is this need for more and better information in a JIT environment that is the focus of this article. How must a firm modify its Logistics Information System (LIS) to support JIT rather than traditional manufacturing? (*Traditional* means production or distribution based on order quantities of at least several periods' requirements, with outbound transportation in full truck loads). What are the key characteristics of a JIT-LIS, and how should it operate? These are some of the questions addressed in this article.

In the next section the literature concerning LIS and JIT is reviewed. Section three traces the evolution of the various systems for inventory management (EOQ, MRP, DRP) and relates them to traditional (push) or JIT (pull) systems and to the operation of an LIS. The fourth section presents ideas concerning how JIT will change the face of LIS for suppliers, and develops a new conceptual model of LIS. Section five contains a description of such a model currently in use in the automotive industry. In the final section, conclusions and suggestions for future research in JIT-LIS are presented.

REVIEW OF THE LITERATURE

An excellent review of information systems in logistics management was completed by Stenger. General principles and practices of logistics system
design are given by Bander. Treatments of JIT and logistics systems include the work by Burba who emphasized inbound logistics, especially opportunities for consolidating inbound shipments as in the JIT inventory system of Toyota. O'Neill and others demonstrated that the need for inventory can be reduced when a good information system is in place. This requirement for a good information system is one of the cornerstones of JIT-LIS.

General issues pertaining to integrated information systems for materials management have also been discussed by a number of authors, including Skjott-Larsen. A review of the American situation concerning LIS was given by Gustin, which he extended to include more general computer applications in transportation and distribution management.

Naturally, the purpose of a logistics information system is that logistics decisions may be systematically based. This can require the employment of 4th-generation software with a combination of operations research and accounting techniques, enabling developing of "what-if" distribution models linked to a current data base involving sub-systems for each of the logistics functions.

Indeed, these notions are central to the concept of a Logistics Decision Support System (DSS). A DSS includes appropriate information files, but more importantly the linking of these through a data base system with access to appropriate model software. Allen and Emshein have discussed DSS for logistics, while DSS for transportation have been studied by Galantone and Norris.

INVENTORY SYSTEMS

Prior to turning to a LIS in a JIT system, it would be beneficial to trace the evolution of the various approaches to the information required for replenishment decisions. This discussion includes the well-known Economic Order Quantity (EOQ) and more recent systems such as Material Requirements Planning (MRP) and Distribution Resource Planning (DRP). Each works well when it is appropriate; however, when applied out of context, results have generally been unsatisfactory. The more recent concepts of push and pull systems are then turned to, which offer insight into the preceding models and to the requirements of a JIT-LIS.

EOQ

The Economic Order Quantity model is based upon a number of assumptions concerning information, the most important of which is that the annual demand or usage requirement of D units be known with certainty. If these units are consumed at a constant rate, the reorder point s can be taken as the (known) demand during the replenishment lead time.

When the consumption or usage is not constant within each period, the EOQ model can still be employed as long as D is known approximately. The reorder point is adjusted appropriately: s is set by choosing a service level p, the probability of no stockout during a replenishment cycle. The difference between s in this case and the preceding one is the use of safety stock, to account for the statistical fluctuations of demand during the lead time, and hence in demand per period. This safety stock inventory is required because of a problem with less-than-perfect information.

MRP

When extending the concepts of EOQ into multi-level items, certain problems arise. Consider a product Z with component parts X and Y. Suppose that an EOQ model for the end-item Z indicates it should be assembled once every three weeks in a quantity of, say, sixty units. For the components X and Y, assuming no requirements for them as spare parts, their demand pattern would be as follows:

<table>
<thead>
<tr>
<th>Period</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>
|        | 1 | 2 | 3 | 4 | 5 | 6 | 7 | As.
| Requirement for X or Y | 60 | 0 | 0 | 60 | 0 | 0 | 60 | 60 |

What if safety stock were employed to protect against fluctuations in the demand for X? In Table 1, the standard deviation of demand for X is approximately 28 units per period, greater than the mean period-demand of 20. Safety stock would thus fall miserably for X (as well as Y). Two-thirds of the time, there could be 30 or more units of X in inventory, when absolutely none was required. Even so, the remaining one-third of the time, it might not be possible to assemble the desired 60 units of Z, since fewer
than 60 units of X may be on hand. If there were better information processing completed on the known information, this inventory could be significantly reduced and in some cases totally eliminated.

Use of MRP to manage the inventories of X and Y, with the time-phasing of component demand solves the preceding issues. It must be realized, however, that what is obvious today about dependent demand was not at all clear 15 or 20 years ago. MRP, by "exploding" the independent demand information (for Z) into dependent demand information (for X and Y), can result in major inventory level reductions.

**DRP**

Martin and others have discussed ways to extend the dependent demand concept to the "outbound side" (see Stenger and Cavinato). Consider a warehouse W supplying two retailers (R1 and R2). Safety stock should be carried at the retail level (R1 and R2), where a superposition of independent demands from customers is realized. However, the warehouse W serving these retailers experiences dependent demand. That is, demand at W is strictly dependent on the demand at R1 and R2. In principle, no safety stock should be needed to cover the retailers' orders.

One key difference between MRP and DRP concerns location. The various steps in an assembly process are usually carried out at a single site. While distribution naturally involves transport between multiple locations. There may thus be some advantage to carrying safety stock at a warehouse, even if it experiences solely dependent demands. However, a better information system between warehouses and suppliers should lead to a minimization of this inventory.

**Push versus Pull Systems**

Another difference between MRP and DRP concerns the management control system. EOQ is typically operated as a "push" system, that is, components X and Y are produced to schedule and they are then sent to the assembly station for Z. However MRP is usually planned as a "pull" system, in which demand information for the end-item Z implies the requirements for components X and Y. DRP could also function this way: demand at the retailers R1 and R2 would pull product from the warehouse W. However, DRP need not be operated in this manner.

Modern communications systems enable a warehouse to be appraised, on a daily basis, of the stock positions of its retailers. If necessary, W may thus preempt their ordering policies. Management may find it advisable, e.g., because of transport economies, to centrally adjust the timing and perhaps the quantity ordered. This would have somewhat the character of a push system. Similarly, the logistics manager may wish to centrally set the safety stock or "base stock" (see Brown) at each retailer, hence it "pushes" a certain amount of inventory to the retailers. This results in a "hybrid" (or push-pull system) where certain quantities are pulled by the retailer and others are pushed by the warehouse.

**Manufacturing versus Distribution**

DRP can be operated in a consistent manner using any of these approaches: push, pull or hybrid. These variations are possible in distribution because management has established a service level p (100%) for finished-goods inventories at retailers. Alternative methods for allocation and control of stock might well furnish the same service for approximately the same total cost.

At the component level in MRP (i.e., X and Y), the service level must be p=100%. (Otherwise, lack of an inexpensive component may cause an assembly line to be shut down.) Now, these components and sub-assemblies in MRP are analogous to intermediate stages in a distribution system of several echelons: Factory-Warehouse-Retailers. Intermediate distribution echelons do not need 100% service because the product is already in finished form. Indeed, it can be shown that a fairly high p can be attained at the retailers with rather lower service at factory and warehouses.

By comparing service levels at intermediate stages in MRP and DRP, a key difference between a system of physical supply and assembly versus a system of distribution can be identified. The general issues in the design of a logistics information system, and how these issues relate to methods for inventory management discussed above are now addressed.

**JIT-LIS**

Just-in-Time manufacturing systems have had a dramatic impact on what is expected from the Logistics Information System. An LIS has traditionally focused on the out-bound side of the equation (for example, see Stock and
However, JIT is forcing a reexamination of this focus so that in-bound transportation is of equal or greater importance to the manufacturing firm. As previously stated, JIT requires very frequent shipments of materials in order to assure that only a minimum of inventory is maintained. Additionally, the low inventory levels require greater attention be given to verifying that shipping schedules are met exactly.

Without proper information from the requesting organization, suppliers cannot meet the fast delivery times required for an effective JIT. The most common approach in viewing the time from order placement to order receipt is the "order cycle" concept. While this concept still maintains a great deal of validity, the timing of the various operations will be unacceptable with JIT. For example, a survey by LaLonde and Zinszer has shown that the average total order cycle time is 10.3 days. This refers to the shipment of finished goods inventory to a fairly wide net of customers (retailers or distributors). This cycle time would clearly be unacceptable for manufacturing organizations operating with only a few hours to one day's worth of inventory. For "physical supply" of components or sub-assemblies, inbound order cycle times for JIT are measured in terms of hours or minutes, not days.

An industry extensively using JIT order cycles is the automotive industry. In one example, the automobile assembly plant places a firm order with the supplier only 154 minutes prior to expected receipt of the completed order. However, to achieve such rapid order cycle times, other systems must be in place.

An assembly plant supplies each JIT supplier with a 3 month order forecast, which is then refined to a 10-day order notice. This notice gives general information concerning the expected quantities of each item required during the next 10 days. On the day of shipment, information is constantly being updated until the firm order is placed 154 minutes prior to dispatch. This firm order not only relates the quantities required, but also the exact loading sequence of each item on the truck. The truck is then required to be at the plant within exactly 154 minutes. If there is any delay in the system, the assembly line could (and has been) shut down, which causes enormous disruptions throughout the assembly plant and its suppliers. Because of the absence of slack in the system, the physical and informational logistics systems must work in unison.

With the critical timing of information in a JIT environment, older batch processing of orders is no longer an option. Any information system that relies on a number of days to process an order is far too slow to be effective in a JIT situation. A JIT logistics information system (JIT-LIS) may require both the requesting organization and the supplying organization to use on-line computer systems that are constantly linked. This linkage has been expedited by the development of Electronic Data Interchange (EDI).

EDI has resulted in significant savings of both time and resources for a number of different firms. This standard was developed as a method of dealing with computer-to-computer communication between different organizations. Without some type of communication standards the inventory reduction results of JIT would be significantly more difficult (if not impossible) to accomplish.

Ordering organizations are also requiring more and different information from their suppliers and carriers. This new information includes such items as statistical control charts, exact (to the one-half hour) shipping schedules, and immediate notification of any anticipated shipping problems. All these additional items need to be incorporated into the JIT-LIS.

For a JIT-LIS to be effective, it will require:

1. A change in focus (from out-bound to in-bound)
2. A change in processing methods (from batch to online)
3. A change in relationships (between carriers, suppliers, and receivers)
4. A significant increase in the volume of information transmitted.

The up-shot of all these changes is that a completely new concept of LIS must be developed for use in a JIT environment. This system, built around the JIT concepts, must be flexible to adapt to changing requirements, allow for the processing of non-traditional logistics information, guarantee rapid processing of information, and be cost effective.
CONCEPTUAL MODEL OF A JIT-LIS

This conceptual model of a JIT-LIS has its foundation in the classical LIS model. This classical model is concerned with the order cycle (from order request to order receipt). However, as was discussed in the previous section, additional information must be included in a JIT-LIS. When coupled with the critical timing requirements of a JIT system, this additional information forces the classical model to be extended.

Moreover, when discussing the JIT-LIS conceptual model, the close coupling of the manufacturing firm with the supplier must be considered. The computer and information processing systems of the two organizations must be compatible and have the ability to interact on a real-time basis. This need forces a closer cooperation between the supplier's out-bound logistics system and the manufacturer's in-bound logistics system. These are "two sides of the same coin" and they must be treated as inseparable in a JIT-LIS.

The JIT-LIS conceptual model is shown in Figure 1. The first step in the process is receipt by the supplier of the manufacturer's long term order forecast, which is a projection of the medium- to long-term requirements of the manufacturing firm. It lists the expected production and shipping requirements, allowing the supplier to plan ahead for any possible changes that may occur. For example, in the automobile industry this forecast can aid a supplier in determining for which parts, on which model, it should be increasing capacity, and for which others it should be reducing capacity.

The information required at this step is product specific information, including product numbers, projected product volumes, expected shipping dates, and any anticipated future special delivery requirements. The information is not tied to a specific order or shipment number at this time because this is a forecast of requirements, not a specific shipping order. Receipt of this information allows the supplier firm to better plan for future events so as to better service their customers.

The second step in the JIT-LIS model is the receipt of the short-term scheduled orders. These orders (usually referred to as firm orders) specify exactly which items are to be delivered. Specific logistics decisions can now be made. Because JIT deliveries are predominantly serviced by trucks, these vehicles should be scheduled into the supplier's facility. Such trucks, which in a number of cases are specially designed for JIT shipments, must be on time and ready to be loaded when they arrive at the supplier's location. If the supplier anticipates any difficulty in supplying the necessary items, the supplier must notify the manufacturer immediately. A JIT system will not allow backordering of items or changes in the shipping schedule without significant disruption after this point.

This step requires the set of information found in the typical purchase order. The information is order and product specific, with item numbers, quantities, and expected delivery dates supplied. At this time, the requesting firm is guaranteeing that it will accept the product, to be delivered at a specific date. What may or may not be supplied at this step is the expected shipping sequence of the product.

The third step in the process is receipt of the in-sequence firm shipping order. This order expands upon the scheduled orders by specifying not only what is to be shipped but also in precisely what arrangement the pro-
The fourth step is the detailed order scheduling on the supplier's shop floor. If the previous forecasts have been accurate and used by the supplier, the detailed scheduling should allow sufficient time for manufacturing the product. In most manufacturing operations, the detailed order schedule would be generated by an MRP system. With the receipt of either the short-term scheduled orders or the firm shipping orders, these orders can be used by the master production schedule of the MRP system. The information needs at this level include the set of items to produce, the volumes to manufacture, the sequence in which the items should be produced, and the due dates or times for each order.

Fifth in the JIT-LIS order cycle is the actual manufacturing of the items by the supplier that constitute the order. During the manufacture of these products, each is held to close quality standards, usually by employing Statistical Process Control (SPC) methods. These methods, when correctly utilized, permit elimination of both final production inspection at the supplier and inbound inspection at the receiving plant.

After the order is produced, the sixth step involves loading the truck for shipment and preparing of the shipping documents. As presented above, the exact sequence of the loading can be a critical factor for the receiving plant. Loading in the precise sequence enables the shipment to be sent directly to the manufacturer's production line. Several steps in the material flow are thus eliminated at the manufacturing plant: (a) no receiving department, (b) no incoming quality inspection, (c) no repackaging the incoming material before it is sent to the floor, and (d) no warehousing or inventorying of the JIT items.

The usual shipping documents must be included with the shipment. This information includes order number, item numbers, and units shipped. Additionally, a truckload sequence listing, which shows the ordering of product in the truck, may be supplied. In certain cases, SPC chart information is also sent with the shipment. It should be emphasized that backorders are not allowed in a JIT-LIS system because of the low inventory position of the ordering firm. Due to this, backorder information is not required because the system will not allow backorders.

Seventh in the process is to notify the manufacturer of the shipment. This shipping notification, very similar to the one sent in the classical LIS model, is typically a computer message that is transmitted electronically when the truck has left the supplier's plant. This allows the manufacturing plant to guarantee that the products ordered are underway. Included in this information transfer are the order numbers, item numbers, item quantities, and expected delivery date and time. The exact expected time of delivery can be crucial when the manufacturer is operating with only a few hours worth of inventory.

The final stage is verification of the receipt of the shipment at the manufacturer's site. This step is optional because, in a true JIT system, the manufacturer will automatically inform the supplier if the shipment did not arrive. The manufacturer will communicate this information because any JIT shipment missed may stop production because of lack of material. Information transmitted typically includes order and item numbers received. Quantities received may or may not be transmitted depending on the quality of the JIT environment. With higher quality environment, the quantities received will always match the quantities shipped, hence retransmitting quantities is redundancy. In beginning JIT systems, or with manufacturers with new suppliers, the quantities received may be transmitted.

The conceptual model can be employed only after certain prerequisite conditions have transpired.

(a) The supplier and the manufacturer have entered into a long-term agreement of cooperation. This agreement, when matched with a blanket purchase order, eliminates the credit approval step of the classical model. Also, the pricing of items is not part of the JIT-LIS system. The price, as well as any price increase, must be negotiated and agreed upon at the blanket purchase order stage.
(b) The supplier and manufacturer have agreed upon a set of timing parameters. Aspects that must conform include the following: length of horizon for the long-term order forecast, the time from receipt of the scheduled order to the time of dispatch, and the time from receipt of the in-sequence shipping order to receipt of those items at the manufacturing site.

(c) Either the supplier or the manufacturer has entered into a long term agreement with a trucking company for JIT deliveries. The supplying firm is usually responsible for the on-time delivery of all parts, hence they are greatly concerned with reliability of the carriers. This increase in the need for guaranteed delivery has, while not lessening the importance of price, emphasized the importance of service. (Hill and Vollmann32 suggest that a manufacturer ensure this service by picking up component supplies in company-owned trucks.)

(d) The supplier and manufacturer have compatible computer-based communication systems. While the two systems need not be identical, it is absolutely vital that each be able to communicate with the other in a timely fashion. This customarily requires that both systems are available on a constant basis, hence the older batch type computer processing is no longer acceptable in a JIT-LIS.

A JIT-LIS IN THE AUTOMOTIVE INDUSTRY

The automotive industry was one of the first to embrace the concepts of JIT in both its internal manufacturing facilities and in its dealings with suppliers. While there is still much work to accomplish in JIT-LIS, the experiences of companies within the automotive industry can provide valuable insights to how the new JIT-LIS conceptual model should operate.

Turning to a specific case, a firm referred to as the Seating Company supplies automobile seats to a major automotive assembly plant. The process of transmission of information and shipment of product closely follows the JIT-LIS model. The Seating Company receives information from the assembly plant, which includes a 12-week forecast, a 10-day production schedule, a minute-by-minute shipping schedule, and advance shipment notifications. The Seating Company ships seats just in time for them to be used in the automotive plant. These seats are in sequence and they are taken directly to the production line without an incoming quality inspection performed. If for any reason the seats are out of sequence or they do not arrive at the assembly plant on time, the Seating Company faces severe penalties, extreme of which is the loss of the contract. With the high penalty cost for failure, the JIT-LIS system must constantly work accurately and effectively.

The first aspect of the information cycle is the weekly transmission by the assembly plant (and receipt by the Seating Company) of the 12-week order forecast. This forecast (usually in weekly increments) specifies anticipated orders for which the Seating Company should prepare. This information is then exploded through the supplier's MRP system, to ensure that sufficient lead time is available to complete the planned orders. While the accuracy of this forecast varies, it provides valuable planning information for the supplier facility.

The next aspect of the cycle is the transmission of the 10-day "JIT" release. This transmission, received daily, becomes the shipping schedule for the Seating plant. It too is processed through the MRP system and provides some of the specifics of manufacturing timing.

The third item of information is the shipping schedule, also referred to as the "sequence broadcast." This highly-detailed information is transmitted in a real-time, on-line basis. Within the automotive assembly plant there is a monitor that scans the vehicles that have passed a certain point in manufacturing. This monitor collects and broadcasts this information to other areas within the assembly plant and to all JIT suppliers. This information is received by the supplier, in some cases every 36 seconds. The Seating Company computer verifies that no error has occurred in the transmission and that no transmission has been missed (using sequential transmission numbers). If no errors are found, the computer calculates where the seat should be loaded on the truck to ensure that it will be unloaded in the proper sequence.

The next step in the JIT-LIS cycle is the actual manufacturing of the product, more precisely, the final assembly stage. Other components and sub-assemblies are completed using the 10-day releases. By building subassemblies and only completing final assembly when the sequence broadcast
is received, the Seating Company need only maintain a minimum of finished goods inventory.

With the information received and the product manufactured, the next step is the loading of the truck. As presented before, this is completed in a specific sequence. The assembly plant is then notified through the Seating Company computer that the truck is in transit.

The final step in the JIT-LIS order cycle is verification that the truck has arrived on time. In most cases this is completed on an exception basis, that is, the assembly plant will only notify the Seating Company if the truck has not arrived and that an emergency shipment will be required. In other cases, particularly when a JIT-LIS is first being started, the supplier firm will contact the assembly plant to verify receipt of the truck.

The automotive industry has revolutionized its logistics information systems. It has gone from the traditional total order cycle to the JIT-LIS cycle. With this modification (and others) the automotive industry has been able to dramatically reduce the amount of inventory maintained in assembly plants, and increase the international competitiveness of the entire industry. With this success, JIT-LIS may become the new status quo of physical-supply logistics.

CONCLUSIONS

In this article, the Logistics Information System (LIS) both for out-bound shipments by a supplier and for inbound deliveries to a manufacturer have been discussed. When the goods in question are components needed for Just-in-Time production, there are specific requirements of the LIS of each firm in terms of the volume, accuracy, and timeliness of information transmitted and received, and the short time scale over which this information must produce action.

Just-in-Time production requires careful coordination between supplier and manufacturer. This may be enhanced using a number of advanced computer-based communication methods, such as Electronic Data Interchange (EDI). Such coordination was a key feature of the conceptual model of a JIT-LIS, and in the specific application of this to the automotive industry.

Additional research could examine a JIT-LIS for other industries, particularly those that may not concern manufacturing (such as grocery products). On the transportation side, backhauls could be sought for JIT deliveries. Ideally, these would be raw materials required by the supplying firm. A model for effective scheduling and balancing such backhauls might, in the future, be cast in a general framework to coordinate production and distribution.

ENDNOTES

3. Same Reference as Endnote 1.


19. Same Reference as Endnote 17.


24. Same Reference as Endnote 5.


31. Same Reference as Endnote 27.

32. Same Reference as Endnote 4.


**ABOUT THE AUTHORS**

Jim Bookbinder is a Past-President of the Canadian Operational Research Society (ORS) and a Past-Chairman of the Transportation Science Section, Operations Research Society of America (ORSA). Before joining the Management Sciences Department of the University of Waterloo in 1982, he had a decade of experience in industry and consulting, most recently (1978-82) as Director of Operations Research at the Toronto Transit Commission. Dr. Bookbinder holds an M.B.A. from the University of Toronto and a Ph.D. from the University of California, San Diego. His current research concerns production/inventory management and physical distribution, with special interest in direct collaboration with industrial practitioners.

David M. Dills is an Associate Professor of Management Science at the University of Waterloo. He holds a B.S. in Business Administration with a Computer Science concentration from California Polytechnic State University and an M.B.A. and Ph.D. in Management Science and Production-Operations Management from the University of Oregon. Dr. Dills is presently serving as Director of the Waterloo Centre for Integrated Manufacturing (WATCMC), an alliance of five research groups and over thirty-five researchers investigating a wide-range of CIM topics. He has published numerous research articles and co-authored two research monographs. His current research is focused in the acquisition and control of advanced manufacturing technology and in the use of information systems as strategic forces within and between organizations.