Implications of Just-in-Time Production on Rail Freight Systems

"Just-In-Time" (JIT) inventory systems are currently very popular in practice and in the operations management literature. These writings have generally assumed that all shipments are done by motor freight. We feel, however, that this assumption can be misleading. The main thrusts of a JIT strategy in production management and inventory control need not restrict the method of delivery as long as that mode can meet certain JIT-created characteristics.

JIT provides railroads with real opportunities to tailor their services to meet the needs of the individual manufacturer or supplier. Possibilities include guaranteed delivery dates, prearranged pickup and delivery, short-term storage, and tardiness penalties. Regularly scheduled priority trains, the bypassing of time-consuming yard functions, close communication with shippers and consignees, and efficient freight consolidation are crucial. More importantly, JIT requires working directly with suppliers, manufacturers, shippers, and forwarders in order to fully exploit the characteristics imposed on freight transportation by such an environment.

It is the purpose of this article to examine these criteria and constraints as they relate to rail freight systems, and, in particular, to suggest ways in which the railroad industry might better compete for its share of JIT transportation. We begin by examining important characteristics of a JIT system and the perceptions of rail freight by JIT manufacturers. Following this, we discuss specific strategies for rail service in a JIT environment, including the use of contracts, intermodal freight, and boxcar/distribution center combinations. Lastly, we present our conclusions and suggestions as to the "ideal" rail JIT system.

Characteristics of JIT Systems

Just-In-Time will impact virtually all areas of the manufacturing process. Factors contributing to the successful implementation of a JIT system have been cited by a number of writers. Important operational characteristics include lower inventories, efficient materials handling, buyer control of transportation, fewer suppliers and carriers, and use of long-term contracts with suppliers and carriers.

Lower Inventories

One way in which Just-In-Time strives to increase the efficiency of production operations is by eliminating virtually all raw material and work-in-process inventories. While a JIT manufacturer will maintain some inventory to buffer against minor fluctuations in material quality and customer demand, this buffer stock is not large. Consequently, a stockout can shut down an entire production line. Inbound JIT shipments must be extremely reliable, since the minimal inventories require these deliveries to be far more frequent than in a non-JIT environment.

Shipment sizes will also be smaller under JIT than for the non-JIT case. As a result, suppliers in close proximity to each other are often encouraged to consolidate, in a single truck, shipments inbound to the same JIT manufacturer. Careful coordination of manufacturer demand and vendor supply is necessary for deliveries to be received by the user at exactly the required time and in exactly the required quantity.
O’Neal concluded, JIT is generally predicated upon faster deliveries, as well as more precise timing and greater control of the carrier organization by the buying or the shipping firm. These characteristics imply a greater emphasis on faster, more responsive modes of transportation. Hill and Vollmann agreed, stating that “the overriding issue in managing incoming transportation in a JIT network is the reduction of uncertainties associated with vendor deliveries.” Later in this article, we will suggest specific rail services for JIT customers.

Efficient Materials Handling

JIT-related changes in materials handling procedures aim at increasing the efficiency of the receiving function. This includes transferring to the supplier the responsibility for inbound inspection. JIT also attempts to bypass the common factory receiving area. Instead, delivery is made directly to the point on the assembly floor where the incoming materials are required. This latter objective can be difficult if freight is received by rail, but in fact, inherent control problems have reduced the popularity of having a large number of receiving points.

Receiver Control of Transportation

In order to ensure reliable and timely delivery of JIT materials, the responsibility for both inbound and outbound transportation is generally shifted from the supplier and/or carrier to the manufacturer. In some cases, such as when the supplier is located close to the manufacturer, the purchaser accomplishes this by performing the pickup himself. If the distance between supplier and user is large, or if the items are not high priority, another party may do the transportation. However, the JIT manufacturer will still make all decisions relating to that shipment.

Receiver control of transportation increases the potential for coordinated outbound delivery and inbound pickup by the same vehicle. Similarly, prior to shipment, a JIT manufacturer may arrange for the consolidation of incoming materials from various suppliers. Both strategies lead to transportation savings, improved equipment utilization, and reduction of inefficient backhauls. However, uncertainty regarding the time of receipt of incoming shipments may be increased due to consolidation, especially if suppliers are not in close proximity. As a result, some JIT manufacturers do not attempt consolidation of shipments (and do not permit such consolidation in cases where their suppliers have a say in transportation decisions).

With receiver control of transportation, identification of delivery problems and alternative actions by all parties is crucial. The move to fewer suppliers and carriers with closer coordination between them helps reduce this supply uncertainty since more elaborate communication methods are now viable. We see no reason why good communication, whether by verbal or electronic means, should be intrinsically better on the part of a motor carrier than for a railroad.

Fewer Suppliers and Carriers

A reduction in the number of suppliers and carriers results in more business being placed with each. There also is increased potential for long-term working relationships among supplier, purchaser, and carrier. For example, contingency plans to deal with unexpected interruptions can be developed on a mutual basis. Thus, closer relationships among all three concerns can help improve product quality, reduce transit time, eliminate administrative paperwork, and lower total costs.

Use of Contracts With Shippers and Carriers

Receiver control of transportation in JIT is facilitated through the use of long-term contracts between shippers, carriers, and consignees. Lieb and Miller noted in a survey that 73 percent of companies using JIT had “negotiated specific contracts with carriers to service their JIT programs.” Malone commented that with motor carrier deregulation, it is now easier “to draw up contracts with truckers playing the pick-up-and-delivery role of the shipper.” Moreover, such contracts can help develop long-term relationships with carriers, thus encouraging coordinated efforts to improve transportation service and efficiency. Indeed, the majority of goods movements today, whether by truck or rail, are carried under contract.

Current Perceptions of Rail by JIT Manufacturers

In light of the above discussion, how can a railroad increase its share of the JIT market? Perhaps the greatest obstacle is the "general
perception that rail transportation is slower and less responsive, especially for LCL shipments." Lieb and Miller noted in their survey of 105 U.S. manufacturing firms that, after implementation of a JIT system, rail usage decreased for both inbound and outbound freight in 49 percent and 35 percent of the companies, respectively. The survey also reported that the two criteria of on-time performance and carrier responsiveness to short-term needs were "important, or much more important, than they had been prior to JIT implementation." 

In a study of 27 automotive firms using JIT, O’Neal noted that while 65 percent of them used some rail transportation, all expected to be less dependent on rail in the future. To the extent that rail shipments are perceived to be associated with large inventories, railroads will have to pursue the JIT market rather than the other way around. Many shippers are willing to pay more for transportation as long as it is timely, reliable, and responsive. Some approaches to meeting these JIT criteria in rail freight service are discussed in the next sections.

**The Use of Rail Contracts in JIT**

As noted previously, close control of transportation is an important part of an effective JIT system. Deregulation has given railroads the ability to better respond to this requirement through use of negotiated contracts with shippers and purchasers. Tyworth, Cavinato, and Langley present a comprehensive list of items to be considered in such contracts. A number of their provisions are relevant to a JIT environment, including frequency of service and minimum volume agreements, penalties for delayed or damaged shipments, and specification of equipment, rates, and service.

Contracts are also useful in exploiting the JIT characteristics of precise schedules of materials requirements and frequent deliveries. It is easier for a railroad to plan its outbound freight service if it is known that a customer is committed to making a shipment each day. In that case, it would be a simple matter of delivering an empty freight car at the same time today’s loaded car is picked up. Bookbinder and Sereda discussed how a railroad could plan empty-car movements by using DRP (Distribution Requirements Planning).

**The Role of Intermodal Transportation in JIT**

Next we discuss how intermodal transportation may satisfy the needs of a Just-in-Time system. For such a shipper, the two basic choices of intermodal rail transportation are TOFC (trailer-on-flatcar) and COFC (container-on-flatcar). We begin with COFC.

**Difficulties with COFC**

The use of common COFC containers by both JIT manufacturers and suppliers encourages consolidation of many small inbound shipments from a number of suppliers. However, the inherent immobility of a COFC container reduces the benefit of this strategy. A container on a truck chassis has little advantage over a regular piggyback trailer if a manufacturer or supplier cannot remove the container from the chassis. Special items such as a "truck liner" container—a smaller container that rolls on casters inside a regular COFC container or piggyback trailer—may reduce this problem for the manufacturer and supplier. However, capital investment in such equipment would be necessary.

The requirement that a railroad have special equipment for placing and removing a container from a flatcar limits COFC handling to intermodal yards. Although a small yard might have a ramp for loading piggyback trailers, it is doubtful that equipment for loading COFC would be available, except in the larger population centers. Because of the chassis and handling requirements, "Railroads would rather have trailers, with no need to worry about chassis and transfers and so forth." 

In conclusion, the above problems appear to limit the present use of COFC in JIT. COFC may be useful only to suppliers and manufacturers located near intermodal yards (in relation to the total length of haul) or to those either possessing the equipment required to remove the container from the chassis or with no need to do so. The growth of domestic freight containerization may lead to technological developments that reduce this limitation. However, at the present time, we use the term "intermodal" to refer only to TOFC in what follows.

**TOFC Terminals and Equipment**

The success of trailer-on-flatcar will ultimately be determined in the TOFC terminals. Since
the time and costs of intermodal shipments are concentrated in the loading, unloading, and handling at these points, the distance hauled must be sufficiently long to allow the spreading of high rail terminal costs and to take advantage of rail's lower vehicle movement costs. Reducing these costs may require a redesign or a relocation to fewer (though more efficient) key-point terminals. The "longer highway hauls to and from these terminals" would thereby eliminate some of the usefulness of TOFC shipping.

Therefore, a JIT supplier or manufacturer located in a center that lacks rail facilities for placing and removing trailers on TOFC rail and road equipment might be faced with a truck haul of significant distance to the nearest intermodal yard. If this haul is done in company trucks or by common carrier hired by the supplier, the benefits of TOFC may be somewhat negated. There are, however, some alternative approaches.

JIT Applications of the AAR Intermodal Plans

A number of authors have outlined the Association of American Railroads' plans for TOFC service. In brief, the basic five plans and their variants differ in the degree of rail service (line-haul, pickup, and/or delivery) and in ownership (private, common carrier, or railroad) of trucks and rail cars.

Approximately 50 percent of TOFC freight in 1984 moved under Plan 2 or its variants. These plans involve railroad-owned trucks with pickup and/or delivery performed by either the railroad (Plan 2) or the shipper (Plan 2.5). We feel that Plan 2 or its variants provide the best opportunity for effective service to the JIT shipper. While not eliminating the longer-distance truck hauls to the TOFC terminal, the shipper will benefit because the road-haul and the rail-haul are done, or at least arranged, by the same carrier. This generally favors the railroad with a trucking branch located near the originating or receiving center. Such joint ownership of a motor carrier by a railroad may introduce organizational structures that are more profit-centered and therefore "better suited to the provision of transportation services." This ability to effectively coordinate truck pickup/delivery and rail-haul is crucial to successfully meeting JIT requirements of prompt and dependable service.

Suppliers to large JIT manufacturers who can ship in sufficient quantities to fill at least two trailers per delivery may benefit from Plan 4. Rates under this plan are set on a per-flatcar basis assuming two trailers per flatcar, one shipper, and one consignee. This plan may also be of use to a freight forwarder or shippers' association that can consolidate a number of small shipments to a single JIT consignee.

Summary

Limited TOFC loading/unloading services could also be provided at designated smaller yards. Stopping an intermodal unit train at every yard to couple or uncouple TOFC equipment would obviously eliminate some of that train's speed advantage. However, to serve the JIT customer located in a smaller center who wishes to ship by rail, it would be necessary to designate some centers between the larger TOFC terminals as regional TOFC yards.

These centers would not, of course, use overhead cranes. Rather, consistent with the smaller size, the lesser demand could be handled adequately with ramps so that loaded TOFC railcars would be ready for the arrival of a regularly scheduled dedicated intermodal train. The current trend towards fewer, larger TOFC yards with lift-on/lift-off equipment, however, has resulted in the elimination of many such ramps and associated rolling stock. These policies may force shippers in centers that lack TOFC facilities — whether ramps or otherwise — to bypass entirely TOFC service in favor of trucks.

In conclusion, TOFC could be used in a JIT system only if the source and destination were such that the loading and unloading to trailers could be done fairly quickly. In large TOFC terminals, this would necessitate efficient priority service or use of special equipment such as the Road-Railer, a truck trailer equipped with a flanged wheel-set for transporting by rail without use of a flatcar.

Boxcar Services for a JIT System

Efficient TOFC handling of the smaller order-quantities prevalent in JIT would call for consolidating, in a single trailer, shipments from various suppliers to a common manufacturer. Often this is not possible. As a result, less-than-truckload shipments are not uncommon in JIT. Such LTL freight is moved by railroads via
TOFC, often with trailers of common carriers such as UPS, or via boxcar.

For the railroad, boxcar shipments yield higher margins than does piggyback service. There are practical advantages as well:

A typical 60-foot boxcar can carry the same volume, but nearly three times the weight as an 89-foot intermodal flatcar with two 45-foot trailers or two 40-foot containers.

For final delivery, the transloading of boxcar freight to truck (private carrier, common carrier, or railway-owned) can eliminate the need for purchaser-owned facilities and equipment. This also greatly reduces the back-haul problem. Re-loading of these shipments, however, requires a distribution center or terminal. The use of such boxcar/distribution center services in a JIT system is discussed in the following sections.

Consolidation, Linehaul, and Local Delivery

A regional transloading depot — not necessarily railroad-owned — would be used to consolidate both LTL and TL shipments from various sources for boxcar shipment to a receiving transloading center. There, one would break bulk for local delivery by truck. Loading and unloading of boxcars at the distribution center could be facilitated by the use of multi-door boxcars, similar to the three-door truck trailer noted in Bookbinder and Locke. A good example of such a car is the Thrall all-door boxcar used by the British Columbia Railway for lumber shipments.

Such boxcar/distribution center services have been implemented by a number of railroads, including Burlington Northern and CSX, with various benefits accruing to the supplier. Besides reductions in shipping charges due to the greater capacity of boxcars and increased competitiveness of railroads, capital investment by suppliers in trucks and warehouses is reduced. As well, the supplier's tracks are more quickly freed for use elsewhere, and the backhaul problem is eliminated for both trailers and containers.

An effective transfer point may also offer product inspection and palletizing, and can make available warehouse facilities for the short-term storage of goods, including a JIT manufacturer's small buffer stock mentioned earlier.

This latter benefit also aids the non-JIT supplier who is accustomed to large shipments at less-than-frequent intervals but must supply the JIT customer through daily deliveries in small quantities. For example, some Burlington Northern facilities will store incoming goods without charge for up to thirty days. Traffic Management discussed the case of a food cooperative that shipped to these warehouses in full boxcar loads, then did local deliveries in smaller quantities for this shipment throughout the month. As a result, not only were transportation costs reduced and customer service improved, but new markets requiring fast delivery had become serviceable.

ABC Classification of JIT Inventories

While a number of railroads offer boxcar/distribution center service, only a few, such as Burlington Northern, currently aim at meeting the time constraints of a supplier or manufacturer in a JIT environment. This does not, however, eliminate the use of rail in serving a JIT customer. For example, Ansari and Heckel noted that in American industries, the JIT concept has so far been limited to a small percentage of all inventory, generally those items classified by the ABC inventory analysis method as type A. Thus, if it is not possible to meet some JIT constraints through railroad shipments, an optimal plan may be to transport type A items by truck (to satisfy time constraints), type B items through a boxcar/distribution center (to reduce freight rates while taking advantage of the distribution center's short-term warehousing features), and type C items by these or other means. Clearly, both JIT and non-JIT industries must make assumptions about the value of inventory, trading that cost off against the cost of shipping to determine the best mix of truck and boxcar shipping.

Regular Planned Shipments

The use of boxcar services in JIT requires that the railroad guarantee the availability of a sufficient number of boxcars on an ongoing basis. Moreover, the loading and unloading of these cars at a distribution center, as well as their linehaul, must be treated as priority freight with strictly maintained schedules. In return, the railroad can benefit not only from the increased frequency of shipment, but also from its regularity. Planning of facility and boxcar utilization, as well as train scheduling, is simplified by the commitment to daily deliveries by a number...
of JIT shippers. Conditions such as these could be included in contracts between the railroad and the shipper.

Conclusions

In the haste of North American manufacturers to jump on the JIT bandwagon, there are examples of Just-In-Time systems employed “out of context,” where the standard arguments in favor of JIT simply do not hold. We know of cases in which the highway journey from suppliers to consignee (JIT manufacturer) is in the range of ten to fourteen hours. Truck is used because of the bandwagon effect; the obsession to operate with no inventories means that large numbers of trucks are on the road from this one supplier to the manufacturer in question. We are aware of other situations in which daily deliveries are imposed even for materials whose weekly usage is in the order of pounds, rather than tons.

We have argued in this article that JIT transportation need not be synonymous with trips by motor carrier, nor should it necessarily institutionalize deliveries on a daily (or more frequent) basis. Rather, transportation in Just-In-Time systems requires precision:

- precise timing of shipment arrivals; and
- precise shipment sizes or quantities.

Along with precision on shipment schedules and materials requirements, JIT is based on information that enables:

- the manufacturer to modify on short notice, but within mutually agreed-upon limits, those arrival times and quantities; and
- constant awareness by the supplier, carrier, and manufacturer of a shipment’s whereabouts and its progress toward the destination.

An “Ideal” Rail JIT System

The wording has been chosen carefully in the above points to emphasize that rail can, in the ideal case, fill the bill. What might be the characteristics of such an ideal case for the use of rail in a JIT system?

The linehaul portion by the railroad should be in the range of 100 to 500 miles. (We are aware, however, of some JIT rail services currently being performed over distances of 1,500 miles, thus illustrating that precision, rather than distance, is the key factor.) If the combined trip is intermodal, the shipper and consignee should each be within, say, one-half hour by truck of the respective TOFC terminals. Dedicated intermodal equipment, such as the Road-Railer, would, of course, be another plus. A short JIT train, carrying goods from several suppliers and consolidated at an intermodal terminal, would bypass rail switching yards. The goods would be of type B in an ABC classification. This merchandise would probably be quite dense, causing a truck to weight out rather than cube out.

Planning and updating of the requirements for rail equipment, whether boxcars or flatcars, could be performed using DRP. The information requirements of JIT are entirely compatible with a railroad’s capabilities. An overall JIT materials plan would be based on rolling schedules for the manufacturing to be carried out, say, over the next one month, ten days, and one day. Suppliers and carriers would receive updates via EDI (electronic data interchange) regarding the fine-tuning of the short-term portion. Computer-to-computer communication is not unique to the trucking mode; Not only is today’s railroad equipped for EDI, but modern satellite systems can now track particular rail cars and report their progress toward the destination on practically a real-time basis.

The increasing use of contracts between shippers and railroads should permit a creative structuring of JIT arrangements, for example, the inclusion of contingent bonuses as well as penalties to the railroads, depending critically on how well the precise timing requirements are met. Before the advent of such contracts, the privileges of “transit” and “diversion” were important attributes of rail transport. It may be that transit could be profitably incorporated in an overall JIT system encompassing inbound physical supply of components, production of subassemblies, and transport to a final assembly plant. Investigation of such an opportunity would require study of a specific case.

We also mention the possibility of “Assembly and Distribution” services. These activities by intermediaries have been discussed in conjunction with programs of shipment consolidation. The context has generally been that of motor freight. We see no reason why an entrepreneurial railroad could not include “A & D” services as part of a concerted effort of advice and action on materials management, freight forwarding, and transportation.

In closing, we add that rail freight services with potential for exploiting the JIT environment are evolving rapidly. Examples include Bur-
lington Northern’s “1-2-1 Service,” Santa Fe’s “Quality Distribution Center” and “Quality Service Network” programs, Conrail’s Steel-Train, and Road-Railer services by Norfolk Southern. Further research, through use of questionnaire or survey, would be worthwhile to investigate the extent and degree of development of services offered by the railroads to JIT shippers and manufacturers.

ENDNOTES


10 Lieb and Miller.

11 Lieb and Miller.

12 O’Neal.


19 Anonymous quotation from “Containers come on strong,” Railway Age (vol. 190, no. 2, February 1989), pp. 28.


23 Welty, “Intermodal: evolution and revolution.”

24 See, for example, Tyworth, Cavinato, and Langley; also see Taft.

25 Taft.

26 Harris and Grimm.

27 See, for example, F. Malone, “How CN moves ahead by renting its,” Railway Age (vol. 181, no. 8, April 28, 1980), pp. 32-33.


29 A. B. McKinnon, chairman & CEO, Norfolk Southern Railway, quoted in Railway Age (vol. 188, no. 6, June 1987), p. 33.


33 “Snobish Growers: A boxcar full of savings.”

34 McKenzie.


36 C. Marshall, senior vice-president, marketing and sales, Conrail, quoted in McKenzie, p. 47.

37 See, for example, Ansari and Heckel; also see Schonberger.

38 Major Road-Railer service is currently offered by Norfolk Southern Corporation. A number of other railroads, including Burlington Northern, Conrail, CSX, and Union Pacific, have run Road-Railer trains within the past few years. The present attitude of many railroads appears to be one of “wait and see.” See, for example, Kevin P. Keefe, “A horse of a different color,” Trains (vol. 49, no. 8, June 1989), pp. 28-37.

39 See Bookbinder and Sereda.

40 See, for example, Bookbinder and Dils.

41 See also Tyworth et al, Appendix 8.1, pp. 215-233.

42 Tyworth et al.