Service Innovation in Spare Parts Logistics in the Business Aviation Industry

R. Klueber a), H. McCann b), R. Wehrle c), T. Knopf d)
CEO of Consilis a), Switzerland
Manager Direct Sales, Jet Aviation b), Switzerland
Director & Dep.Vice-President SCM EMEA, Jet Aviation c), Switzerland
CEO, Fiege Logistics (Switzerland) d), Switzerland

a) E-mail: roland.klueber@consilis.com
b) E-Mail: hugh.mccann@jetaviation.com
c) E-mail: rolf.wehrle@jetaviation.com
d) E-mail: thomas.knopf@fiege.com

Abstract — The challenges of establishing a global information and document exchange system are described in the case study of Jet Aviation. The context is the improvement of its spare parts supply chain with Fiege Logistics to expand its reach through Internet based software as a service (SaaS) solution. The resulting innovative solution has the capability to integrate several worldwide operating organizations with different IT infrastructures and environments to increase the total customer service.

Keywords — SaaS, service supply chain, networkability, systems integration, business-to-business document exchange, reverse logistics.

I. INTRODUCTION

The demands on global logistics performance are increasing continually by customers, manufacturers and 3rd party providers [1]. A unique solution to this challenge is proposed in a business network of mutually dependent business partners. This challenge posed to Fiege – as a worldwide logistics provider – was to meet the requirements of a tender and to compete with bigger competitors not only in price but also service to deliver an encompassing logistics and information service. Consilis helped to develop a solution to meet the customer’s and the customer’s customer and supplier’s requirements on behalf of the logistics provider.

The paper starts with the description of the business network the solution needed to fit in. Chapter 3 describes the innovation areas that were required to be addressed in the resulting solution (chapter 4). The hurdles and learnings (chapter 5) prepare for the concluding chapter.

II. THE BUSINESS NETWORK HETEROGENEITY AND CONTEXT

The spare parts activities in the business aviation industry can be characterized by little planability of demand, worldwide scope and a large number of required parts due to the long life cycle of an aircraft of up to 25 years.

The business network in focus consists of the (1) aircraft and main component producers (OEMs), the (2) logistics providers, (3) logistics agents, (4) repair and maintenance service providers, (5) field engineers, and (6) customers. All parties except for the customers can be considered as networks themselves and can have mutual relationships between each other.

The business relationship between the OEMs and Jet Aviation can be characterized by a high reciprocity [2, 3] since they serve the same customers and rely on each other in the sales and repair process of parts.

The business network in focus consists of several aircraft manufacturers with different sizes, business-to-business experience and capabilities. Similarly, Jet Aviation, Fiege, and the agents have heterogeneous ERP and maintenance service systems in place.

III. SERVICE INNOVATION AREAS

A. The Business Challenge

The spare part supply chain is vastly different from the finished goods supply chain through its global service networks with reverse logistics flows that add complexity and costs. Furthermore, the situation of the service provider Jet Aviation servicing eight different aircraft manufacturers, own worldwide service centers, and a mobile customer base makes statistical analysis and forecasts of service incidents per part impossible [4]. Additionally, there are many aviation regulations, valuable parts and high-impact events that accumulate high costs if the aircraft is not in use. This is why the most urgent way of delivery is called “aircraft on ground” (AOG). The most often used service level signifies the highest service priority, shortest transport time and usually correlates with high costs. Delays or wrong information in the supply chain can lead to high expenses as the AOG service level is required to reduce negative customer impact or contain penalties.
In contrast to the manufacturing supply chain the service supply chain has different parameters that influence the design of it (see Table 1).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Manufacturing Supply Chain</th>
<th>Service Supply Chain at Jet Aviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Demand</td>
<td>Predictable, can be forecast</td>
<td>Always unpredictable, sporadic</td>
</tr>
<tr>
<td>Response</td>
<td>Standard, scheduled</td>
<td>Same day or next day (ASAP)</td>
</tr>
<tr>
<td>SKUs</td>
<td>Limited</td>
<td>15-20 times more</td>
</tr>
<tr>
<td>Product portfolio</td>
<td>Homogeneous</td>
<td>Heterogeneous (8 Aircraft Suppliers)</td>
</tr>
<tr>
<td>Delivery network</td>
<td>Depends on product, multiple networks</td>
<td>One network capable of delivering different service products</td>
</tr>
<tr>
<td>Inventory mgmt. aim</td>
<td>Maximize velocity of resources</td>
<td>Pre-position resources</td>
</tr>
<tr>
<td>Reverse logistics</td>
<td>-</td>
<td>Handle returns, repairs, exchanges &amp; disposal</td>
</tr>
<tr>
<td>Performance metric</td>
<td>Fill rate</td>
<td>Product availability (uptime)</td>
</tr>
<tr>
<td>Inventory turns</td>
<td>6-50 p.a.</td>
<td>1-4 p.a.</td>
</tr>
</tbody>
</table>

The conclusion was that the service offering of the logistics provider Fiege had to meet unplannable demand with maximum flexibility of services provided by employees and IT systems as well as an agent network in countries without own presence. The extended requirements were to offer a fully transparent tracking and tracing system, electronic invoicing and electronic document management on a global scale. Jet Aviation conceptualized the basic idea back in 2000 as “Freight Concept Vision 2000” but then the technical implementation was not yet cost efficient since the Internet-based business applications were not considered mature enough. In 2007 Consilis was asked to help Fiege to design and establish a future-oriented solution that implements the initial vision and would help to meet the following challenges:

The challenges were to (1) reduce costs through consolidation of shipments (2) reduce transit time, (3) increase customer satisfaction, (4) reduce required assets in the service chain, (5) increase transparency of status and information on documents, (6) integrate logistics integrators such as FedEx, UPS or DHL, (7) improve efficiency in the invoicing reconciliation and booking process. This meant that the existing operations could grow with a growing customer but also that the IT-intensity of the operations would need to increase within a few months.

The innovation Jet Aviation was willing to put into place was to improve the global service operations and to optimize the service supply chain with mutual benefits for the whole network.

The solution was to build a relational contract [5] that would allow Jet Aviation and Fiege to grow and roll-out a worldwide service solution to meet the above stated challenges. One major element was to include a software based service that was not yet in full operation all parties were convinced that there will be learnings in the future that might require a change of the then implemented solution.

B. Process Challenge

The service processes within the business aviation industry encompass a wide range of different service scenarios. There are (1) maintenance activities, (2) warranty and (3) non-warranty repair services, (4) interior design and completion activities which Jet Aviation offers for eight different aircraft manufacturers.

The activities take place in one of the 12 global service centers or at the location where an aircraft had a major defect (aircraft on ground). In the latter case avionic engineers, tools and parts need to travel to the location where the aircraft is stranded. In terms of logistics and service processes the challenge was to cover the (1) transport of parts, (2) exchange of parts, (3) core and offcore return process within one single software solution.

The involved actors encompass at minimum the following. (1) OEM in cases the parts are resent for repair or overhaul. (2) Fiege as a lead logistics provider and its agents (3) Logistics fulfillment provider (i.e. airline or integrator) (4) Jet Aviation as initiator of a shipment.

Fig. 1 depicts the flow in case of the offcore return process where the part that is required is ordered at the manufacturer and the defective part is sent back at the time the new part is installed and tested in the aircraft.

The challenge of this process is that the offcore part may exceed the contractual return time with the OEM. The cases when OEM was allowed to charge penalties for late returns of offcore parts needed to be reduced. This became another design requirement for the lead logistics provider role of Fiege and but also Jet Aviation as the reasons for late returns were within Jet Aviation’s, Fiege’s and the OEM’s sphere of

![Fig. 1: Process Overview for Core & Offcore Return Processes](image-url)
control. Reducing the time to identify the location and the current ownership of parts became key design criteria for the information system.

C. The Technical Challenge
The challenge to be met was that the detailed infrastructure of the OEMs and their capabilities to exchange data and documents electronically was not known (networkability [6]). Therefore, the solution needed to encompass a wide range of networkability reaching from OEMs without Internet access to those where some sites had ERP systems and business-to-business messaging systems are able to provide shipping data, shipping document, and certificates in electronic form.

Technical innovation is not the elements but the combination:
(1) Integrated platform to be able to offer the service worldwide
(2) Internet based solution to allow for a high ease of access, a low cost infrastructure, ability to use existing infrastructure and low maintenance costs
(3) Integrated document management to manage status and part information
(4) Integration competence of the service provider to match the heterogeneity of information systems in the business network
(5) Existing integration of logistic integrators
(6) Integration of traditional airfreight business
(7) Configurable software for fast roll-out
(8) Little to no technical entry hurdle
(9) Active information if unscheduled delays happen (supply chain event management)

The challenges of business-to-business document exchange have been highlighted by several authors [7, 8, 9]. In the case of the customer Jet Aviation a first mover strategy was applied since the industry works with the same type of certificates that extend the typical logistics documents (e.g. master airway bill). The solution chosen offered the document management capability initially for transport related documents.

During discussions between Fiege, Consilis and Jet Aviation the value of exchanging business documents was identified, elaborated and added to the system. The document management functionality was used to exchange not only transport related but also service maintenance related information on the single item level: (1) Identification of serial numbers, (2) tracking of single parts, (3) maintenance status and history etc., (4) certificates of parts. Additionally, documents such as commercial invoices, delivery notes can be added to the new service solution automatically or via web-based document upload by named users.

The main advantage gained is that the documents are available at the time the parts are shipped compared to the previous situation where the information was only available 24 to 48 hours later when the parts were received and checked. Further additional information about the parts is connected with the shipment and is made available to the receiving parties prior to the arrival of the physical shipment. This information advantage helps to optimize internal operations at Jet Aviation as the repair schedules can be better planned upon the actual availability of parts with a higher reliability of what is in transit and when it will arrive.

As the term Tracking & Tracing (T+T) is ambiguous it will be defined here as following the entity from A to B by delivering the current status of a shipment in its flow (tracking) and backward analyzing where a part has been or is (tracing) [10]. The challenge was to include tracking on line item level in the SAP ERP system of Jet Aviation and also to provide a provider spanning tracking system that is able to integrate several existing tracking systems. Further the use of the FES extended the scope of the system from the classical public transport between sender and receiver to the internal operations of Jet Aviation by substituting the existing shipping applications on the ordering party’s side.

Another challenge of B2B solutions is the interoperability between the participating actors [11]. Since the first conception was only based on interviews with Fiege and Jet Aviation’s experience and an uncompleted feedback from a technical capability screening of the OEMs the requirements were not complete. Therefore, the solution required to integrate a wide networkability spectrum of OEMs and logistics partners. It ranged from small agents with strong links to the OEMs with little IT competencies and capabilities to multi-national companies with a high capability to exchange documents and data electronically or companies that were in the transition process towards a new version of their ERP system that offered a higher networkability.

IV. Solution Elements

A. Functionality Overview
The resulting service offering was coined Fiege E-Services (FES) to depict that it covers a myriad of electronic and human services with different degree of services used by each partner in the service supply chain. The service was blueprinted [12] and the business model [13] collaboratively developed between Fiege and Jet Aviation.

Fig. 2 further displays the integration of the main business partner types and the information exchanged between the business partners and Jet Aviation.
1) Shipment Management defines the process of managing the delivery of goods from Jet Aviation to a Business Partner or customer.

2) Consolidation is the process of combining separate transport orders into single shipment units.

3) Freight calculator is functionality for the sales department of Jet Aviation to use the tariff system and calculate the price of a shipment before it is sent in order to support tender processes.

4) Tracking and Tracing (T+T) describes the functionality to track a specific shipment and part.

5) Document management contains the access to the transportation, commercial and technical documents that are shipped on a shipment item level if required.

6) Event management is the functionality to inform the relevant person via e-mail or short message service that some shipment is not in schedule.

7) Electronic invoicing (E-invoicing) describes the direct electronic transmission of invoices to Jet Aviation’s ERP system. Invoice reconciliation is the process of a web-based authorization of deviations from the tariff or extra costs. Jet Aviation’s freight cost controllers can authorize these deviations and accepted deviations are automatically repriced and invoiced.

During the project work and after analyzing the operative processes two further modules were activated:

1) Jet Aviation’s legacy shipping software was migrated to an integrated application of FES which can combine shipment orders, allows entering details (e.g. serial numbers or shipment instructions) and adding documents (e.g. certificates), print delivery notes, and set the status to ready for dispatch. The last function is the trigger for the responsible logistics provider to pick-up the shipments.

2) Jet Aviations goods-receiving process is also enhanced by a migration of the former data-base application which registered incoming goods to an additional module provided by FES. The module sets the status of the goods received and is able to register parts that were not ordered by Jet Aviation. The module provides functionality to confirm that the shipment is complete, defective or it is only a partial delivery before it is registered in the SAP ERP system. Using this further process integration informs Jet Aviation that a delivery has been received and enables to act earlier if a shipment is incomplete.

These two process extensions increased the reach of the FES from coverage of the public logistics space to include the first process steps of Jet Aviation’s logistic processes. Through this integration additional benefits are achieved without adding further interfaces.

Technically the SAP R/3 system from Jet Aviation uses a B2B middleware to sent purchase orders formatted in XML via http as transport protocol to the FES system offered as SaaS solution provided by inet-logistics. The purchase orders are converted into shipment orders in FES and are made available to both the business partners that need to deliver the parts as well as to the logistics partners and Fiege who acts as a lead logistics provider (LLP). The transport orders are stored with the status open until the part is ready to be shipped. The shipping department of Jet Aviation can combine the purchase orders or separate those according to the actual availability of parts and this is updated in the FES. After completion of the packing process the interim labels are printed and Fiege picks the parcels.

According to the service level, total amount of shipments and destination Fiege decides which carrier is best to save costs through choice of provider and consolidation while still keeping the defined delivery dates. Fiege then prints the documents from FES and directly orders the pick-up by an integrator or delivers the packages to an airline. The booking can be achieved via a direct interface with the booking system of the integrators or via online booking systems of airlines.

During the shipping process the status updates are either updated manually or automatically by the logistics provider’s shipping systems status update functionality. The receipt of the goods at the OEM is either entered by the logistics provider or directly by the Jet Aviation’s goods receiving module of the FES. The proof of delivery is then generated and Jet Aviation documents the delivery of the package to the goods entry desks where the parts are checked and entered into the SAP R/3 system.

The inet-logistics server is built on a 4-layer web architecture. It solution runs on (1) Oracle database, (2) Java, JSP-based Application Server, (3) Web Server, and (4) Java-based thin clients via standard browsers. The solution provides certified interfaces to SAP as well as master and transaction data, and logistics document standards. On the messaging layer the networkability is high due to synchronous (e.g. web services or http(s)) or asynchronous message (e.g. ftp, smpt, X.400,
OFTP, MQ-Series) capabilities. Supported document standards are Logic80, Odette, FORTRAS, IDOC, XML, VDA, Flatfile, EDIFACT. Mobile devices such as scanners, PDAs, mobile phones can be integrated to achieve a high networkability. A further advantage is the existing connections CEP providers such as DHL, FedEx, UPS, TNT and several other logistics providers.

The final contract contained forward looking elements as the roll-out of the FES only started in a few locations. This meant that the future status quo is roughly described and two monthly steering board meetings are used to keep track of the progress and to assure both parties perform as intended. The relational element of the contract covered for adaptations of the FES to adapt the initial design until the first OEM was using the system for import and export shipments to one of the Jet Aviation’s locations.

The system design as SaaS was vital to be able to roll-out swiftly compared to local installations. It reduces the resource consumption at the business partner side and lowers barriers to use the e-service [14].

Monitoring of the implementation success has been considered as a central component of the roll-out process. Not only KPIs but also regular meetings were established to guarantee that Jet Aviation and Fiege share the same commitment to success of the project.

B. Integration Alternatives to Increase Flexibility

Due to the inherent problem of incomplete knowledge about the networkability of all the participating approximately 70 locations of the relevant business partners FES needed to provide a high flexibility. The decision was made to offer the following three ways to integrate business partner’s locations:

1. Web-based human access
2. Direct B2B Interfaces
3. Exchange of in-house application by FES modules offered as SaaS solution

The one that was used most is (1) which reflects that a low entry barrier reduces change inertia and that the networkability is relatively low compared to other industries.

Next to the flexibility of interaction and integration the flexibility to integrate additional locations and requirements was critical. With only short notice of two months from first information to implementation the FES was configured to support a temporary service center of Jet Aviation during the Olympic Games of 2008 in Beijing.

C. Implementation Methodology

A central element during the design and the roll-out phase was to establish a clear picture of the benefits of the solution for all participating parties. The implementation followed the Business Networking methodology [15]. Since Jet Aviation, Fiege as LLP as well as the customers and suppliers (OEMs) need to gain from the successful implementation of the FES a clear benefit calculation was required. Fig. 3 shows the cost benefit logic that was used during the roll-out process to highlight the benefits of using the FES to the OEMs. The total supply chain costs composed by logistic costs, inventory costs and costs of delay or lost customers are positively influenced by the use of the FES in comparison to today’s situation.

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D. Future Process and Business Partner Extensions

The solution is currently in its worldwide roll-out process. The natural extensions are to support the upstream and downstream processes. On the upstream side a conceptualized visibility solution for spare parts is in the evaluation process. In the consecutive phase an order management solution with data exchange with the ERP systems can be used to link to the existing shipping, tracking and invoicing processes. This extension would foster the efficiencies in the sales and purchasing processes.

A further potential is customs access to build the trust and facilitate faster transit times at the airports.

On the downstream side a connection with the inhouse warehousing solution has been conceptualized. The implementation depends on the richness of data exchange and benefits for Jet Aviation depending on the project decision on the future warehousing solution.

V. IMPLEMENTATION HURDLES

The adoption problem is similar to that of early procurement e-markets with split benefits [14]. In contrast to the situation of most e-markets the reciprocity between business partners in
the situation described above increases the likelihood of success.

However, the buy-in of each involved party required to establish inter-organizational service chain is still high since the impact on existing processes can be considerable if several business partners need to agree to work on one single software solution. Adoption problems arise when the benefit is not visible for the department the user works for but on a company level. For example, updating the information in the sales department of an OEM became a major hurdle since the obvious benefits from using the system are generated in the shipment process, service planning or on the inventory side. If the sales department is incentivated on turnover then non of these benefits becomes a direct benefit for this group.

The adoption barriers can be lower if the volume and improvements in process, transparency and technical networkability allow for a B2B data exchange. An implementation barrier discovered with one OEM was that they had an internal ERP system roll-out process that prohibited early adoption.

Another hurdle was the initial data quality and it is still a challenge during the roll-out of the FES as a deeper integration with the SAP ERP system and additional locations from Jet Aviation using another type of ERP system will be using this service.

The offering exclusively a web service based solution would not have been sufficient since the business partners did not have the required networkability to use such a web service or they did not integrate the shipping process in their ERP system. Therefore one key success factor was to offer proven and widely adopted technologies such as browser-based access to the FES. Although it cannot offer the full automation benefits of a B2B interface it reduces the adoption barriers. By taking this decision to offer different degrees of automated data exchange and using an Internet-browser based solution some OEMs were able to experience the benefits in their operations prior to financial investment.

VI. CONCLUSION

The presented solution is developing with the networkability progress of the involved partners and other OEMs that will be integrated.

The innovation is the combination of elements within the business aviation industry:
1. Build in flexibility of the system design to provide the requisite variety [16]
2. Extended tracking & tracing functionality in terms of reach and scope
3. Integration of inter-organizational transport and business document management
4. Methodology to include and build on learnings during the roll-out process.

The more automation the less redundant double entry of information is required. However, the investment decision for the interfaces needs to be taken and few of the business partners were capable or willing to start with a direct interface.

To lower that hurdle an initial phase with some manual data entry helped to reduce the adoption barriers. If the employees see the benefits in their daily work then the decision to invest into an interface is more likely.

Future functional developments might be an extension of the process towards in-house logistics processes and the extension towards the visibility of spare parts.

REFERENCES
Networking and as a business development manager at an electronic marketplace in Switzerland. He is founder and CEO of Consilis - a Switzerland based consulting company specializing in innovation in logistics and information processes and systems. He has numerous publications, editorships and presented papers at conferences such as AIM, HICCS, ECIS.

Dr. Klueber is member of SwissICT, IEEE, Gesellschaft für Informatik (Germany) and ISACA (Swiss Chapter). He holds ITIL®/Service Manager certificate. His research interests are service chain management, web service success enablement and IT Governance. He is responsible for the design and further development of the FES.

Hugh McCann is manager direct sales at Jet Aviation responsible for the sites in Basel and Geneva. He holds a Hons Dip in Public Relations from Dublin Institute of Technology and is working in Business Aviation for the last 10 years. He is project manager for the FES system for the Jet Aviation Group of Companies.

Rolf Wehrle holds a masters degree in electrical engineering (Dipl. El. Ing. FH) from the School of Engineering of the University of Applied Sciences Northwestern Switzerland (FHNW). He works for Jet Aviation since 1978 and held several different positions starting with avionic engineering, management of airline aircraft maintenance, division manager and member of the board positions. Currently he is Director & Dep. Vice-President SCM EMEA and steering committee member for the FES implementation.

Thomas Knopf holds a masters degree of the University of Basel. He joined Fiege Logistics (Switzerland) Ltd. in 1992. He is member of the executive committee since 1999 and since 2004 CEO of Fiege Logistics (Switzerland) Ltd. He is also steering committee member for the FES implementation.