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Editor's note: This is another in a series of articles profiling members of the INFORMS Roundtable.

FedEx presents 'playground' for O.R. practitioners

Big companies have complex systems.

Wait. That sentence was not finished.

Big companies have complex systems to design and operate.

Hold on. There is more.

Big companies have complex systems to design and operate, which makes them a playground for operations research practitioners.

FedEx falls into the big company category. The recent 2010 FedEx Annual Report shows that the company had \$34.7 billion in revenue. More than 280,000 team members provide service to over 220 countries. There are 664 aircraft and more than 80,000 vehicles moving eight million packages a day. All those employees with all those vehicles moving all those packages on a daily basis provide problems that need to be modeled and solved.

FedEx Express is the express airline subsidiary of FedEx Corporation and is the world's largest express company.

The operations research group at FedEx Express has been solving operational challenges since the early stages of the company. The group operates as an internal consultant, working on specific issues for various departments. Customers within FedEx Express include Air Operations, U.S. Operations, Central Support Services, Air Ground Freight Services and International Operations.

FedEx Founder Fred Smith introduced the "People, Service, Profit" philosophy at FedEx. If you put your people first, they will in turn provide quality service and profit will be the end result. People, Service, Profit also works well when grouping operations research problems. Without getting into too much detail on solutions, the playground of problems includes the six listed in the following groups:

People:

1. Problem background: FedEx Express must schedule tens of thousands of workers to match the anticipated work. Work fluctu-



FedEx Express schedules tens of thousands of workers to match anticipated work.

ates with the amount of packages at any specific location. Specific workers have specific skills and must be matched to specific work.

Requirements: FedEx Express needs to match available workers to the shifts that need to be covered.

Approach: A multi-stage mixed integer program is used to solve this problem. All work tasks must be identified by time of day. Workers and skill sets are documented. Work must be grouped into shifts for full-time and part-time work. Specific employees are assigned.

2. Problem background: FedEx Express has a group of analysts that design the delivery and pickup routes for the couriers. The need

All About the Roundtable

INFORMS has two types of members: individual and institutional. The latter (usually a company) joins by joining the INFORMS Roundtable and appointing as its representative the person in overall charge of O.R.

The Roundtable has been very active since its founding in 1982, with three meetings each year and much communication in between. It, its member institutions and its member representatives take a strong interest in how INFORMS serves the needs of practitioners, and have undertaken many initiatives and provided many services toward this end. These involve, for example, public awareness of O.R., both of the annual INFORMS conferences, continuing professional education, one of the prizes and various committees.

In addition, the Roundtable has an advisory responsibility to INFORMS. One bylaw states that it "... shall regularly share with INFORMS leadership its views, its suggested initiatives and its implementation plans on the important problems and opportunities facing operations research and the management sciences as a profession and on the ways in which INFORMS can deal proactively with those problems and opportunities ..." By tradition, it meets with the newly elected INFORMS president-elect each spring to discuss practice-related topics of interest to him or her, and with the entire INFORMS Board each fall to discuss topics of mutual concern.

The Roundtable membership comprises about 50 organizations. Further information is available at <http://roundtable.informs.org>.

This series of articles aims to share with the INFORMS membership at large some information and insights into how O.R. is carried on in practice today.



FedEx moves more than eight million packages a day.

for a new route structure varies based on package growth and facility limitations. The work must be done with the help of local operators to make the implementation successful.

Requirements: FedEx Express needs to balance the workload for analysts planning the courier routes.

Approach: A generalized assignment approach is used and solved with an integer program. The current workload of the analysts must be reviewed, as well as their availability for future work. A list of facilities that require a restructure must be compiled. Other considerations included in forming the list of facilities are the total number of courier routes, geography and route complexity. With this information, an optimized assignment of the analysts must be provided to management.

Service

3. Problem background: FedEx Express volume fluctuates from day to day. The delivery routes are designed to meet a specific demand, but the couriers must expand or reduce route coverage based on volume changes.

Requirements: FedEx Express needs to balance the workload and optimize the routes for the delivery couriers.

Approach: A heuristic-based vehicle routing approach is used to solve this problem. All deliveries for a specific day are verified for a facility. The delivery routes are then optimized based on volume and drive time. The solutions are provided to the delivery couriers.

4. Problem background: FedEx Express has facilities throughout major metropolitan areas. The couriers work at these facilities sorting and processing packages. The routes driven by the couriers must begin and end at these facilities. It is important to be close to the customer as that leads to better service.

Requirements: FedEx Express needs to determine the optimal location for facilities.

Approach: A classic location analysis model is used to solve this problem. The number of shipments to and from every



FedEx deploys 664 aircraft and more than 80,000 vehicles.

customer must be determined. Those packages must be divided into courier routes. The distance to begin each route as well, as return to building for each route must be determined. The best location for a facility will include this input and then be passed on to management for review.

Profit

5. Problem background: FedEx Express must invest in aircraft and facilities. As the international market continues to grow, larger aircraft are desired. Fuel efficiency is a major factor. These larger, newer airplanes are costly. They must be parked at airport facilities, some of the most expensive property in the world. These facilities must have support equipment able to move and sort packages. The purchase of aircraft and airport facilities requires significant lead time.

Requirements: FedEx Express needs to determine the number and size of aircraft required by the system five to 10 years in the future. The size of the supporting facilities and equipment needed must also be estimated.

Approach: A multi-stage mixed integer program is used to solve this problem. The operations research groups must put together a forecast of packages and weight for five to 10 years in the future. The information must include package flow from each airport to each airport. The number of aircraft available and connections to hub facilities must be determined. Input also includes the cost of operating aircraft as well as capital. With the information, an optimized network must be built.



FedEx provides service to 220 countries.

6. Problem background: FedEx Express has 664 aircraft that move throughout the world. Making sure that the right aircraft are in the right place at the right time is an ongoing task. Flight schedules are created months in advance and are refined as the actual implementation date moves closer. During implementation, the actual available aircraft are actually assigned to the flight schedule.

Requirements: FedEx Express needs to match aircraft with flight schedule.

Approach: The operations research technique known as the tanker scheduling approach is used to solve this problem. The actual aircraft total must include those available for service, those in

maintenance plus those being used as spares. Certain aircraft are not allowed to fly into certain airports. Restrictions include noise and time-of-day. The actual assignment of specific aircraft to the flight schedule is optimized.

The six problems described above are just a few of the many opportunities to apply O.R. techniques at FedEx Express. One of the ongoing challenges is to apply a technique to each problem that will provide a solution that is easily understood and successfully implemented. **IORMS**

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I F O R S 2011
Conference for the International Federation of Operational Research Societies
<http://www.ifors2011.org/>
Melbourne Convention Centre, Melbourne, Australia
10–15 July 2011