TOWARDS CONDITION BASED MAINTENANCE FOR EMCS

Fokker Service is a Dutch maintenance company with headquarters in Hoofddorp. The company provides maintenance, modification, and repair service for aircrafts like Boeing, Embraer, and Fokker aircrafts. Our case study in Fokker Service focuses on promoting condition based maintenance (CBM) for Electro Mechanical Components (EMCs). For the maintenance of EMCs, Mean Time Between Unscheduled Removals (MTBUR) is a key performance indicator. Operators ask for an annual improvement on MTBUR, while Fokker Service also wants to outperform by providing longer MTBUR. One way to achieve this goal is to promote CBM practices so that an EMC will be removed when its condition reaches a certain limit (detected by condition based monitoring techniques). Such limit is before an unscheduled removal, so less EMCs will experience unscheduled removals. For EMCs experiencing unscheduled removals, MTBUR will become longer.

MODEL ILLUSTRATION

In general, maintenance practices can be classified as corrective maintenance (CM) and preventive maintenance (PM). And for PM, it can be further classified as usage-based maintenance (UBM) and CBM. In Fokker Service, unscheduled removal (UR) is a practice of CM, while soft time removal (STR) holds the idea of UBM. Therefore, to promote CBM in Fokker Service, we will focus on the different scenarios to turn UR and/or STR to CBM removal (CBMR).

Scenario 1 is to turn UR to CBMR. The idea is to collect real time monitoring data from EMCs. Such data can be from the sensors that are installed by Fokker Service. This sub scenario is named as S1_own. The data can also be from the sensors that are installed by operators. Fokker Service can negotiate with operators to gain such data through their information sharing. This sub scenario is named as S1_sharing. The key structure of Scenario 1 (both S1_own and S1_sharing) is illustrated in Figure 1. Instead of turning to "EMCs for unscheduled removal", some "EMCs in work" would turn to "EMCs for condition based removal" if they are diagnosed well. Although there's certain chance (illustrated by "Failure rate" in the model) that some "EMCs for condition based removal" would turn to "EMCs for unscheduled removal", less EMCs will experience unscheduled removals. In other words, for EMCs experiencing unscheduled removals, MTBUR will become longer.

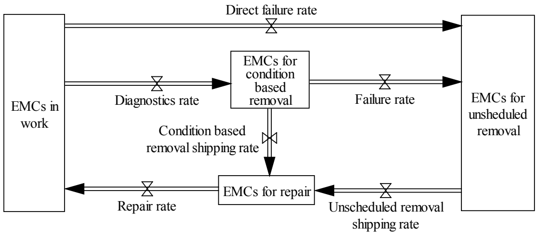

Figure 1. The Key Structure of Scenario 1

Scenario 2 is to turn STR to CBMR. This idea is to inspect the EMC condition on site during periodic maintenance check. If the condition is not OK, such

EMC will be removed during next STR (if possible). If the condition is OK, nothing will be done. The key structure of Scenario 2 is shown in Figure 2. By adding condition inspection on site, the quality of STRs can be improved, as some of them (i.e. when the condition is OK) are not necessary. Meanwhile, the "Failure rate" from "EMCs for soft time removal" to "EMCs for unscheduled removal" will be decreased. This will lead to certain improvement on MTBUR (that is generated by such "Failure rate").

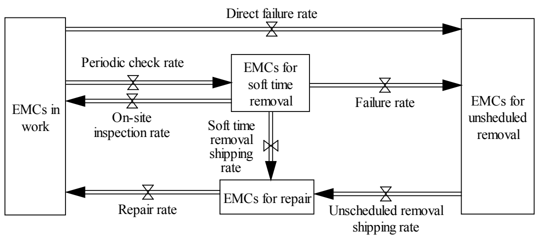

Figure 2. The Key Structure of Scenario 2

Scenario 3 is to use CBM techniques to support UR and STR. The idea is to use CBM techniques during first shop inspection to know more for the next removal (either UR or STR). The key structure of Scenario 3 is demonstrated in Figure 3. By learning from first shop inspection, Fokker Service can improve the quality of EMCs, therefore lowering "Direct failure rate" and "Soft time failure rate". The decease on "Direct failure rate" will then lead to the improvement of MTBUR.

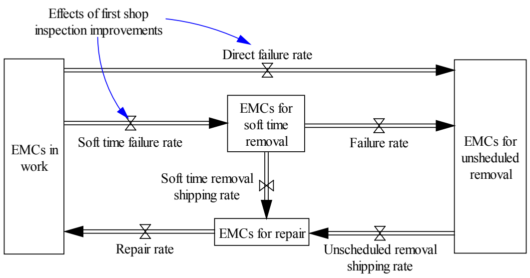

Figure 3. The Key Structure of Scenario 3

Besides the key structure for each scenario, there is a general structure for all scenarios to evaluate the performance, which is shown in Figure 4. The "Lock-in effect" only appears in S1_own, so we put it in parentheses. The assumption of the "Lock-in effect" is: if Fokker Service installs its own sensors, operators can be locked by such new service and would like to accept more service from Fokker Service. Service that is brought by the "Lock-in effect" will trigger an exponential growth on "Revenue", but 80% of such "Revenue" will be the "Cost" to provide such service. Except for the "Lock-in effect", the increase on guaranteed MTBUR ("GMTBUR") will lead to an improvement on "MTBUR" that is perceived by the operator, which will later lead to an increase on "Revenue". Please note the symbol "||" means there is a delay between two variables. We assume that 1% increase on "MTBUR" leads to 1% increase on "Revenue". Meanwhile, the "Cost" is the sum of "Condition based improvements cost" and "Operations cost", which consists of "Operations cost for UR" and "Operations cost for CBMR" or "Operations cost for STR". In the end, the "Cumulated Margin" is determined by "Revenue" minus "Cost". The "Cumulated Margin" is the performance we will evaluate. It is the accumulation of margins of a certain period. In our model, such period is 2 years (our simulation length).

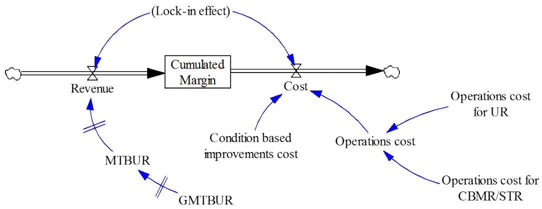

Figure 4. The General Structure to Evaluate Performance

SIMULATION RESULTS AND POLICY SUGGESTIONS

S1_own has the best performance under our assumptions or even without the relationship between "MTBUR" and "Revenue". The drawback is that it needs at least 13 months to reach the break-even point. The first challenge to achieve success is to realize the lock-in effect, while the second challenge will be the negotiation with operators to charge more by improving "MTBUR".

S1_sharing and Scenario 2 have also achieved reasonable performance, and they are easier to implement (without the lock-in effect). Compared to Scenario 2, S1_sharing is highly influenced by the relationship between "MTBUR" and "Revenue". Therefore, the challenge to implement S1_sharing is to negotiate with operators so that Fokker Service can charge more by improving MTBUR. Compared to S1_sharing, Scenario 2 needs about 4.5 months to reach the break-even point. This may become a concern when doing decision-making.

Topsector Logistiek

FACTS

Researcher Dhr. Quan Zhu (quanzhu.nju@gmail.com)

University Tilburg University

Supervisors Prof. Henk Akkermans (ha@uvt.nl)
Wouter van Dis (wouter.vandis@fokker.com)
Menzo van der Beek (menzo.vanderbeek@fokker.com)

Company Fokker Services B.V.

ProSeLoNext project – Powered by:

Gordian Logistic Experts
TU/e Technische Universiteit Eindhoven University of Technology
UNIVERSITEIT TWENTE.
Erasmus Universiteit Rotterdam
Tilburg University

This activity was co-financed by the Netherlands Organization for Scientific Research (NWO), on behalf of the Ministry of Infrastructure and Water Management.

6441