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CPN-DES MODEL FOR ASSESSING BOARDING INTERACTIONS IN AIRCRAFT

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ABSTRACT

The current paper presents a case developed with a methodology that goes one step further than the current studies related to the study of the boarding process. The methodology used in this work integrates efficiently the passenger interactions that enter into the boarding process at the cabin. The resulting approach is a robust one that combines the power of a modeling formalism such as Coloured Petri net (CPN) together with discrete event simulation allowing the integration of stochastic behavior with formal relations specified in the semantics of CPN. The resulting approach allows better analysis capabilities than the studies performed so far.

1 INTRODUCTION

The turnaround time (TAT) of an aircraft is the time it takes for the ground services to set an aircraft for the next flight once it is parked at the gate during consecutive flights. Depending on the type of company, the turnaround will be more or less long (Basargan, 2004). In order to reduce the TAT it is necessary to reduce the duration of the steps that compose the critical path as much as possible. For the low cost carriers (LCCs), the boarding and deboarding processes are key for achieving this objective. This is the reason why scientific community has put focus on different policies and methods for improving these processes.
Different authors have put focus on the way to improve the boarding process. Most of them put their efforts in analyzing the strategies for the boarding process. The different improvements are achieved through different strategies such as the ones presented by Marelli, Mattocks, and Merry (1998), Van Landeghem and Beuselinck (2002) and Steffen (2008) among others. The review reveals that the studies have used simulation focusing mainly in the boarding strategy. Moreover, recently scientific community is taking into account other factors that have an influence in the boarding efficiency such as age, companions, family relationships, passengers travellers with bags, disabilities etc. From the review, it is clear that in order to improve the boarding/deboarding processes it is necessary either to perform real-time experiments or use digital models that integrate more characteristics that play a role in the process instead of taking conclusions based only in the simulated strategies for the boarding process.

2 CPN-DES APPROACH

In this paper, discrete event simulation (DES) simulation is combined with CPN for a more robust approach. The advantage of using a modeling formalism with the simulation model using a DES software is that the modeler can first identify the causal relationships using the CPN approach and then they can be integrated in the DES for governing the behavior of the resulting model. The result is a high-detailed simulator that can be extended with more characteristics (stochastic and deterministic) than the ones that can be achieved using either CPN or DES alone.

A discrete-event system (DES) model has been developed in which the micro-operations such as identifying a person in the seat, moving forward-backward to let the other passengers reach their seats are based on the CPN modeling formalism. The advantage of developing a model that uses DES with CPN is

that the causal relationships are formalized and identified using the CPN approach. In addition, the model can be verified testing different behavior properties such as boundedness, liveness (deadlock analysis) among others. Since the behaviour is modelled using the CPN approach, the extension of it is just a matter of adding more transitions to the CPN model or adding more colors and then implement them in the logic of the DES model.

The CPN model is composed by 16 transition nodes and 3 place nodes. The case study put focus in the boarding procedure of an LCC for a A320-200 aircraft (Airbus 2005). The different stochastic and deterministic variables are incorporated in the model so that the resulting simulator has high detail and is able to simulate and analyze the impact of the interactions of passengers within the cabin. Figure 1 illustrates the methodological steps for developing the model and analyzing the problem case.

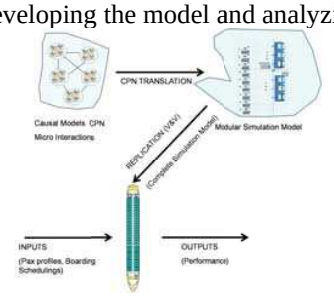

Figure 1. Modelling approach for the cabin model

3 CONCLUSION

We analyzed the case of the A320 using a methodology that combines CPN with a DES approach. The results obtained show that the passenger interaction is relevant in the total boarding time. For this reason, studies should consider also the interactions inside the cabin besides putting focus only on the boarding strategies. The methodology used is a robust one that will be further explored to study the processes in which human factors play an important role for optimizing the processes of an airline.

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