ATC Global 2016
Project Modern Taxiing
Mathieu Cousy
ATC Global - Project MoTa

**Project's objective:**

Design a ground control system that facilitates the integration of autonomous tugs on an airport.

**Project's research questions:**

- What are the performance gains, if any, due to modern taxiing technologies? (throughput, time to taxi, situation awareness)

- What are the costs associated with using the modern taxiing technologies? (workload, trust, etc)
MoTa : Overview

Current situation in Roissy-CDG:

• Paper strips

• Static ground control interface
MoTa : Overview

A new tactile interface prototype :

- Tower simulator
- Ground control interface
- Algorithms for routing suggestion
- Validation campaigns
MoTa: Overview

New modern taxiing techniques:

- Taxi tugs (Taxibot inspired). It has more impact than EGTS or WheelTug
- Empty tugs use taxiways
- Autonomous, do not require ATC clearance when empty
MoTa : Ground Controller Working Position
MoTa : Ground Controller Working Position

Route modification

Alerts & conflicts detection
MoTa : Multi Agents System

- Route suggestion and automated tugs guidance
- Real-time (re)planning of the vehicles according to operators’ clearances, global objectives, and unexpected events.
- Both human-piloted vehicles and autonomous vehicles
- Routing and detaching/attaching operations
- Airport traffic is a dynamic environment with uncertainty
- Multi-agent systems (MAS) are a set of autonomous entities communicating and sharing an environment to accomplish a task.
MoTa : Validation Campaigns
MoTa : Validation Campaigns

35 minutes validation scenarios :

- Medium workload 35 a/c, 60 movements/hr
- Hard workload 56 a/c, 90 movements/h
- Operational events: Restricted area, Pilot error, Towed a/c, Taxiway closure, Wind configuration change.
- 18 ATCOs total.
- Quantitative logs (taxiing time, stop and gos, clearances given...)
- Neuro-physiological measures (EEG, ECG, eye tracker) + questionnaires (NASA-TLX, SART)
MoTa : Validation Campaigns

October / November 2014

XP1 : current conditions with paper strips

October – December 2015

Workshops & Development

XP2 : tactile interface & routing

Workshops & Development

XP3 : Autonomous tugs

Data Analysis, Design enhancements and more
MoTa : Validation Campaigns

- Introduction of a new interface prototype
- Introduction of a new taxiing concept (7 tugs in medium, 10 tugs in hard scenario)
- 45 minutes training scenarios
MoTa : Performance Evaluation

% system information:
- xp2 : 89.5 %
- xp3 : 93.2 %

Radio usage in minutes (35 min total)

% treated a/c
MoTa : Performance Evaluation

System Information Interaction length:
- xp2 : -9.4 %
- xp3 : -7.4 %
MoTa : To be continued...

AUTONOMOUS VEHICLES

TOWER SIMULATION

ROUTING ENGINE

ATCO HMI

AUTOMATION

AUGMENTED TOWER

AIRPORT CDM
Continuation: AIRPORT CDM

● DMAN integration:
  – Make good use of higher precision taxiing times estimates
  – Continuously update taxiing time to account for unexpected events

● Collaboration between ATCOs:
  – 2 ground controllers sharing the same tactile table when traffic increases
  – Coordination between local, ground and apron controllers

● Integration of airlines / airports constraints:
  – Manage parkings already in use or flight delays with airlines operations
  – Handle special conditions together with airport operations.
Continuation: further AUTOMATION

**Investigate datalink or a/c communication usage:**

- ATCO routing clearances can be shared with a/c
- A/c transfer to next sector could be silent
- Still design work to be done to handle communications errors.
Continuation: further AUTOMATION

SESAR 2020 project TACO:

- Human operator become an overall system supervisor

- Automated system accomplish complex tasks and shall be able to transfer responsibilities back to controller in a timely and graceful manner

- Controller defines automation strategy at different level of controls
Continuation: AUGMENTED TOWER

SESAR 2020 project MOTO: The embodied remote tower
Continuation: AUGMENTED TOWER

SESAR 2020 project MOTO:

To move the radar picture towards the calling plane, the user stares at the arrow indicating its location for 300ms.
MoTa : Conclusion

- MoTa examined integration of new technologies on airport ground taxiing
- Three experiments conducted with 18 ATCOs
- MoTa is a work-in-progress but results are promising
  - Increased throughput, decreased time in ground sector, decreased radio frequency usage
  - But... reductions in situation awareness, increased workload with tugs, distrust of the system (more training needed)
- Wealth of design comments collected to improve upon the overall design and utility

http://ihmaero.recherche.enac.fr
Mathieu Cousy : mathieu.cousy@enac.fr
Raïlane Benhacène : railane.benhacene@enac.fr