Aircraft maintenance and engineering (M&E), and maintenance, repair and overhaul (MRO)

Advanced Information Systems and Business Analytics for Air Transportation

M.Sc. Air Transport Management
May 16-21, 2016
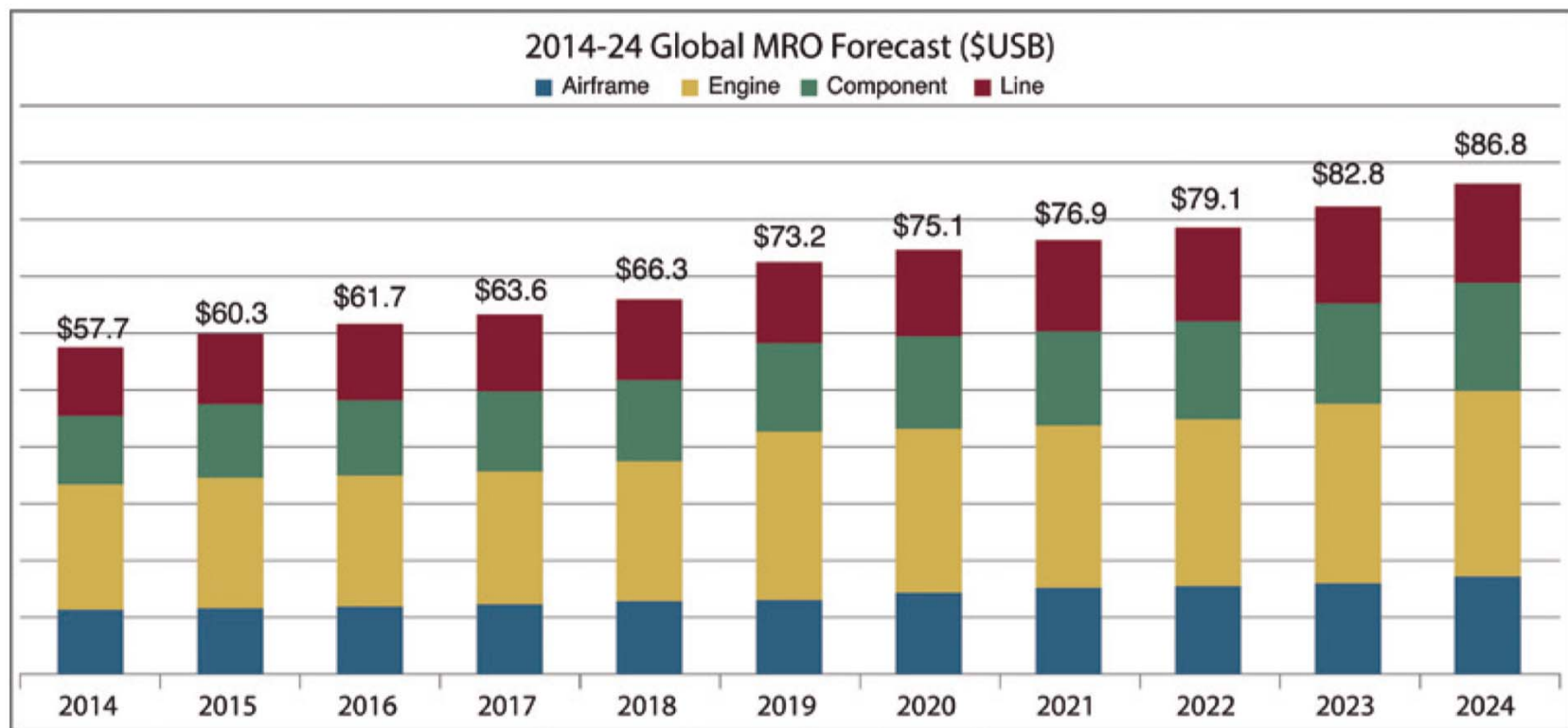
Slides prepared by Benny Mantin

Fig: 1 Global MRO Forecast

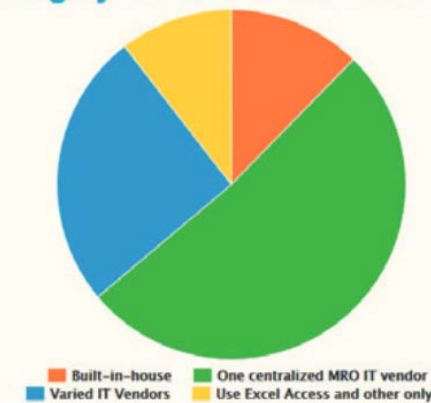Source: TeamSAI 2014-25 Global MRO Forecast

Operational trends

Over 50% use one MRO software vendor. 11% use Excel and Access to manage aircraft maintenance.

- Such software are complex, require regulatory responsibility
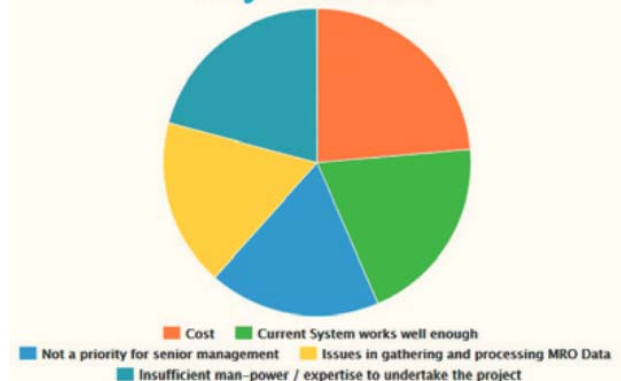- Possibly high degree of loyalty

70% of companies who did not have a M&E / MRO IT Solution are considering purchasing or developing a solution. Cost and insufficient man-power / expertise are the major reasons why companies have not yet implemented a software.

- Somewhat concerning as they do not recognize yet the power if IT and big data

Does your company use M&E / MRO Software to manage your Aircraft Maintenance?

- Built-in-house
- One centralized MRO IT vendor
- Varied IT Vendors
- Use Excel Access and other only

If your company doesn't have a M&E / MRO Software what are the major reasons?

- Cost
- Current System works well enough
- Not a priority for senior management
- Issues in gathering and processing MRO Data
- Insufficient man-power / expertise to undertake the project
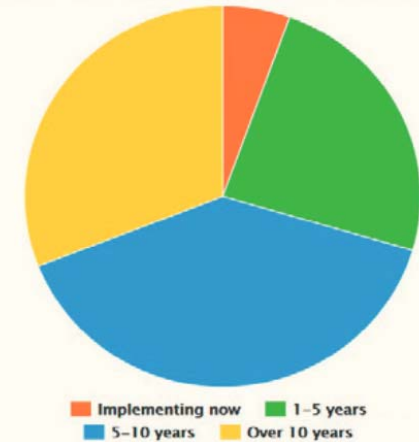
Source: Aircraft IT MRO Survey 2015

Operational trends

- 47% of companies surveyed have over 500 IT users. 19% have less than 50 IT users
- Over 70% of companies surveyed have used M&E / MRO Software for over five years. 6% are currently implementing a solution.
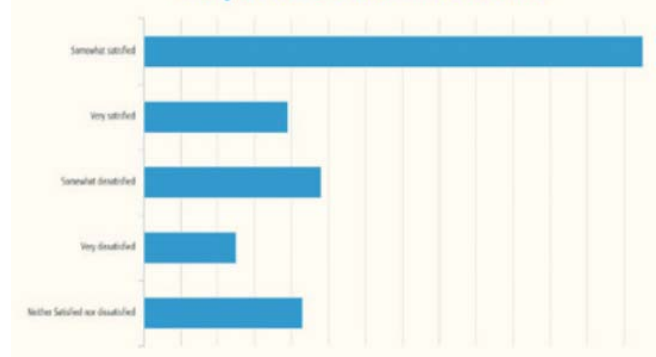 - For most organizations the decision is not whether to use an IT system, but rather which solution
  - Trade-off: adopt system that best matches requirements (while experiencing a disruption) or sticking with the vendor who knows you well.
- 26% are dissatisfied with their current M&E / MRO Software. Only 13% are very satisfied

How long has your company had the current software?

- Implementing now
- 1–5 years
- 5–10 years
- Over 10 years

How satisfied is your company with your current M&E / MRO Software?

- Somewhat satisfied
- Very satisfied
- Somewhat dissatisfied
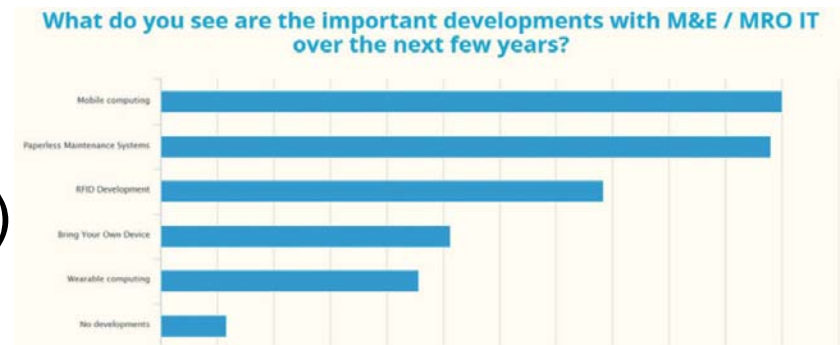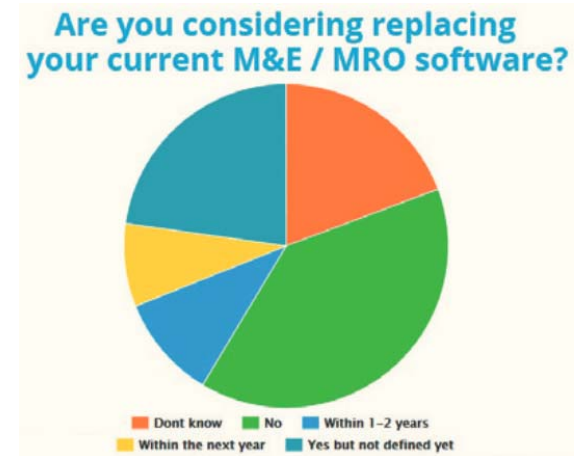- Very dissatisfied
- Neither Satisfied nor dissatisfied

Operational trends

- 18% are considering replacing their current M&E / MRO software in the next two years
- The most important developments over the next few years
  - Mobile computing (27%)
  - Paperless maintenance systems (27%)
  - RFID (19%)
  - Bring your own device (13%)
  - Wearable computing (11%)

Are you considering replacing your current M&E / MRO software?

Dont know — No — Within 1–2 years — Within the next year — Yes but not defined yet

What do you see are the important developments with M&E / MRO IT over the next few years?

Mobile computing
Paperless Maintenance Systems
RFID Development
Bring Your Own Device
Wearable computing
No developments

Source: Aircraft IT MRO Survey 2015

MRO Big Data Analytics

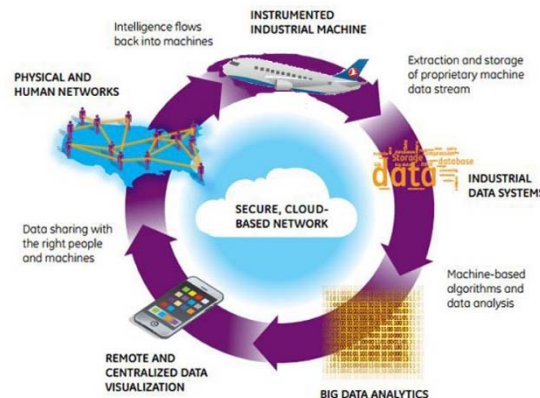| MRO Analytics – Big Data Analytics	
Operational Effectiveness • Total maintenance cost by fleet types, maintenance checks, material & labour • Actual vs. planned labour and material • Labour skill utilization	**Inventory optimization** • Required vs. available quantity • Slow and fast moving parts • Fill rate analysis
Supply Chain Effectiveness • Vendor analysis • On-time delivery by vendors • Lead days analysis	**"50+ industry standard KPI's platform agnostic"**

Source: Aircraft IT MRO

Predictive Maintenance

🛩 Thus far: preventive maintenance

🛩 Can we actually predict when a failure is about to occur?

🛩 Such a system requires significant

- Data from various sources
- Appropriate tools for analytics
- Subject matter expertise
- Tweaking of the algorithms to refine them over time

PREDICTIVE MAINTENANCE

Predictive Analytics Tools
Subject Matter Expertise
Fine tuned Algorithms
Consolidated Organized Data

Historical Trend Data · Online Aircraft Data · Planning and Forecast Data · OEM Data

Maintenance

Aircraft Maintenance Routing: Aircraft routing while incorporating maintenance opportunities.

Tail Rotation: the routing of aircrafts

Maintenance scheduling:
- What maintenance?
- Which aircraft?
- Where?

Strategies: (both are sequential)
- Ignore actual maintenance requirements, generate maintenance cycles
- Schedule maintenance tasks, plan route on a day-by-day basis

Search for feasible solution:
- Often low utilization
- Maintenance workload fluctuation

Integration of the two (powerful algorithms coupled with Monte-Carlo simulation) resulted with (according to Bombardier) 50% reduction in non-revenue flights, reduction in routine checks, process automation
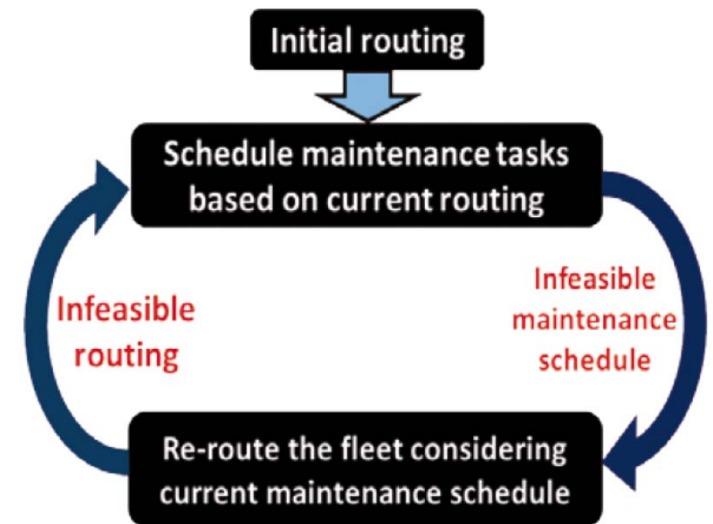
Maintenance

- Another consideration is big data
- Predictive analytics: predicting unplanned maintenance
  - Combat systems maintenance in the UK's MOD resulted with 20% cost savings
- The challenge: picking the patterns
- Out of 500GB maybe 0.1GB is useful for necessary predictions
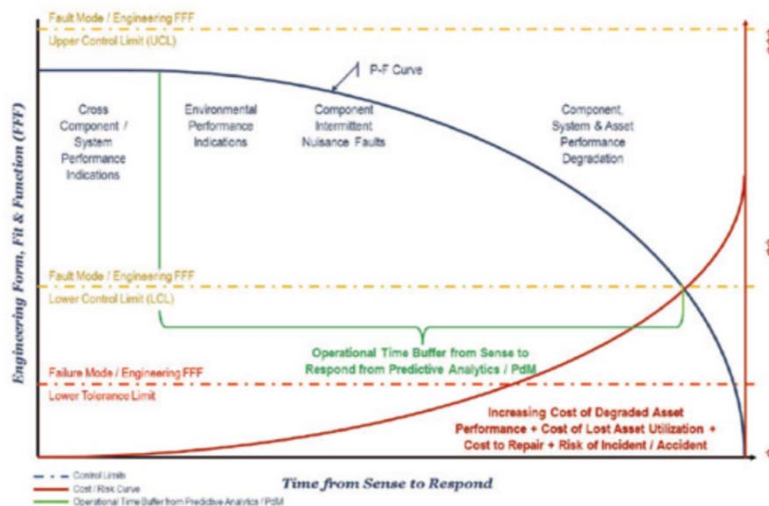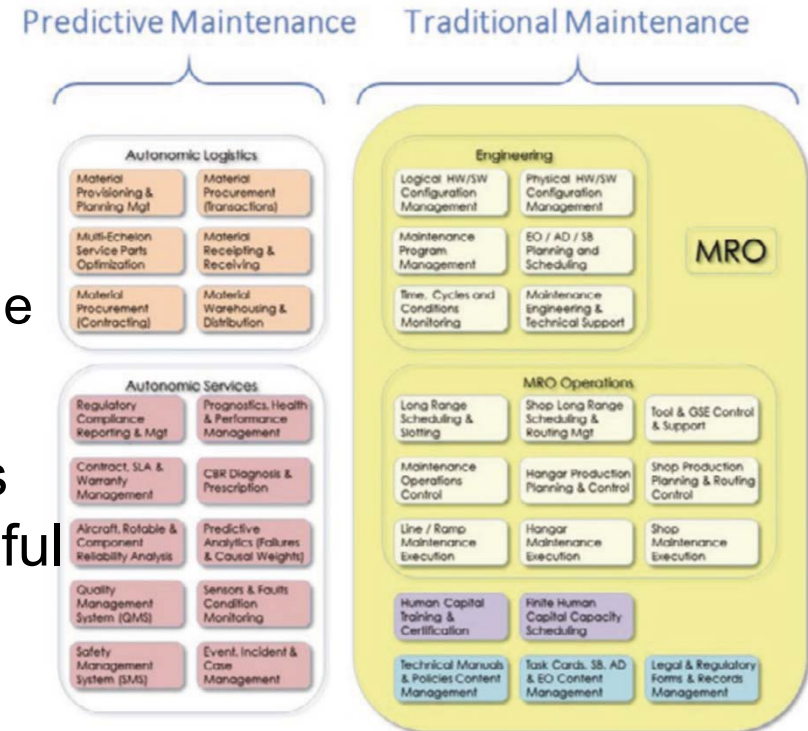
Big Data

✈ Sources of data:
- Own (ERP)
- Employees (emails, social media)
- Suppliers (their ERP)
- Customers
- Internet
- Etc.

✈ Consolidation of data can lead to
- Predictive analysis
  - Expecting future outcomes
- Behavioral analysis
  - On-going improvements in methods and processes
- Real-time analysis
  - Here-and-now decision making

How would it work

- Consider Flight EX-1234 from New York JFK to Amsterdam-Schiphol
  - During the flight, the systems indicates that one of the flight control computers is failing
  - It needs to be replaced
  - The information is sent to the main platform
  - The system start planning the maintenance procedure
    - Will tap into the inventory information
    - Will look into staff availability
    - It may also communicate with other suppliers' systems, find better/faster solutions
- The system would also improve regular maintenance
- This shall result with
  - More efficient operations
  - Reduction of human errors

AA's M&E tablet program

🛩 **Mechanics need mobility**

- Cannot run back and forth between aircraft and office

    - Parts availability

    - Aircraft status

    - Past maintenance

    - Progression of maintenance

    - At DFW, with more than 70 gates, aircrafts are not always where they are expected to be, mechanics need real-time information

AA's M&E tablet program

Benefits:

- Tablet rings tells mechanic about assignments
- Upon arrival to gate:
  - Tells what has to be done
  - What has been done in the past
  - Tells Ops ground that mechanic is at the plane
  - If necessary, initiate boarding delay
- 1,200 CMMs (component maintenance manuals) were digitized
  - Immediately updated
- Focus on process:
  - Replaces work cards and calculations (elimination of errors)

AA's M&E tablet program

- Challenges
  - Connectivity
    - An issue when you operate in 50 countries
      - Developed expertise in buying tablets overseas and replacing cellular cards
    - Mix of cellular (better outside) and wi-fi (better at terminal)
    - Offline capabilities (at cockpit)
  - Regulation
    - Compatibility with FAA
      - Coordinated process and explained benefits to CMO (certificate management office)
  - Initially only Samsung
    - Some prefer iPad, but had to resolve infrastructure security issues
    - Now employees have choice (but no Microsoft yet)
    - HTML 5 works anywhere
  - Suitability for mechanics
    - Minimal typing
    - Zoom, touch
  - Frequent updating
    - Every 30-45 days addressing comments from mechanics
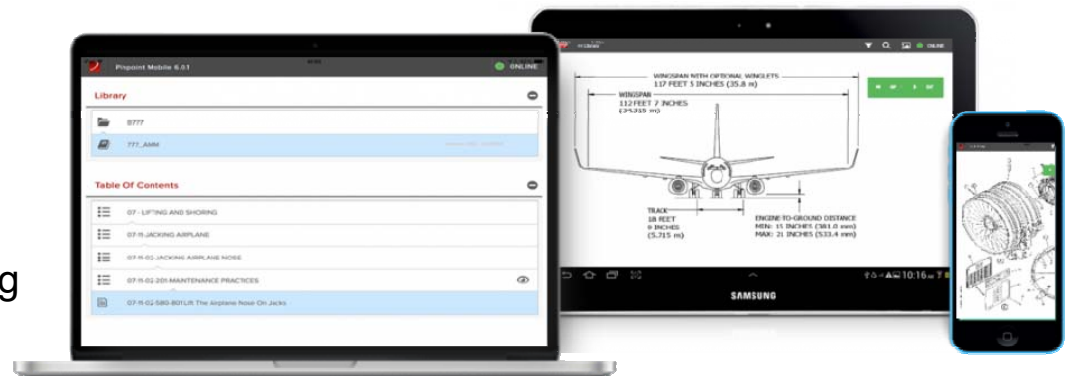
RFID at TAP

Started due to external requirement in 2007:
- An engineering customer wanted to ensure tools are kept separately
  - Parts/tools can be mislaid
  - Raising safety, quality, efficiency concerns

Teamed up with Airbus: project MEERA (Mobile Enabled Engine Repair Application)
- Took 3 years to go live
- Mistakes in the development process:
  - Proof of concept shall replicate normal operations, conditions
  - However, done separate from production, so everything went well
  - Back in production, realized many labels were missing
- Investment: €750,000; expecting 4 times ROI within a year

RFID at TAP

ROI expectations too optimistic
- Slow learning curve
  - Knowing where the parts are is not sufficient, still need to scan
  - Need to train mechanics how to place parts on the rack
    - Enable quick scanning
    - Solved by purchasing circular polarization RFID
- Need to educate: will not solve all problems.
  - Will make some processes more efficient. Need to identify.

Develop strategy
- This is not a separate tool
- Start with engine parts
- Next proceed with tools and GSEs (ground support equipmen
- Future delivery of A350 come with integrated RFID
- Will follow with chemical products and lastly in line maintenance

RFID at TAP
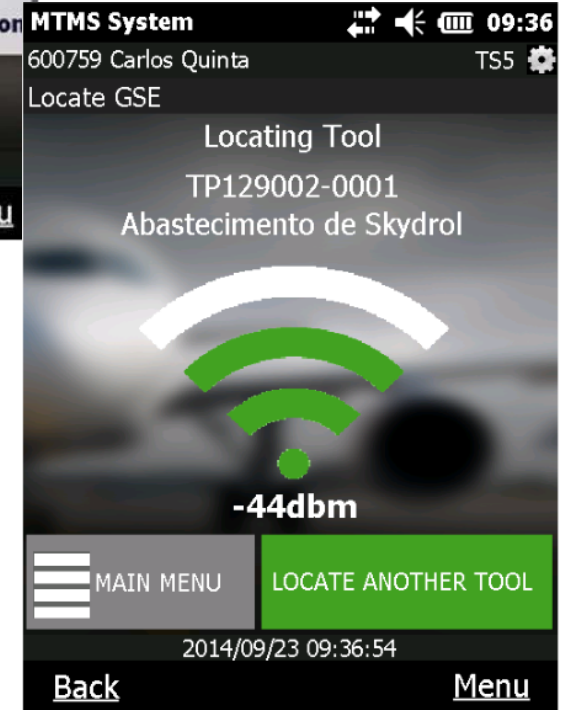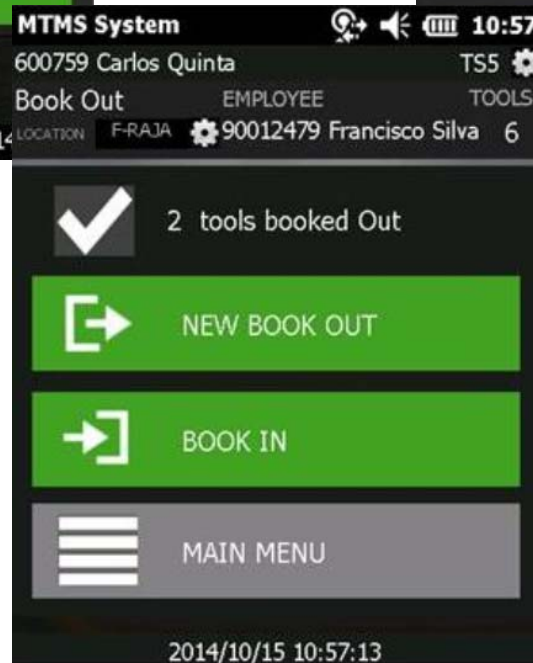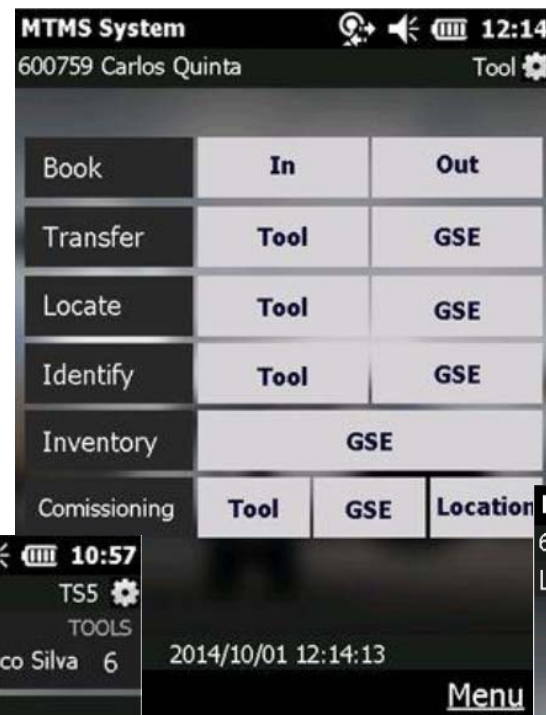
RFID at TAP

Tools and GSE
- RFID and barcode (to leverage existing technology)
- Many tools: half specific, half generic
- Existing tool system is offline: four stores relying on manual updating
- Existing GSE not controlled, relying on proper return
  - A lot of time spent due to misplacement
- Cost benefit analysis does not justify investment…
  - Focus on quality, safety, and image
  - This is also part of the comprehensive solution
- Used RFID for GSEs but not for tools
  - Tools are already barcoded
  - 20,000 tools; hundreds of different sizes and sha results with many RFID tag types
  - Which tools to tag? Too many small tools
  - Importantly, fast inventory is required frequently for tools
  - Existing barcode system works well
- Required the installation of wireless infrastructure

Trends

- Maturing mobility
- Additive manufacturing
  - 3D printing
- Wearable devices
- Analytics

APPENDIX

Maintenance billing

TRANSIT / DEPARTURE CHECKS, DAILY CHECK MAINTENANCE SERVICES AND 'A' CHECK SERVICES RESPECTIVELY
Billing can be based on 'Power By the Hour' (PBH) for major/ captive customers; as a fixed price per event or purely T&M (time & material) for ad hoc / non-contracted customers.

AOG SUPPORT SERVICES
Charge for time & material with a 'part thereof' clause for 'per man hour' or 'per man day' calculations.

WHEELS SERVICES AND BRAKE ASSEMBLY
Bill at the standard rate for (contracted part # only) replacement or overhaul, with the inclusion of clauses on consumables and expendables, plus agreed labor hours and rates. Adhoc service rates for FOD (foreign object damage) rectification for labor, NDT (non-destructive testing), and materials.

BATTERY SERVICES
Charge at the standard rate for periodic, regular and general overhaul with a clause on logistics.

ENGINE CHANGE
Rates and charges for specified engine type, station, agreed TAT (turn-around times), scheduled/ unscheduled change with inclusion clause for expendables, consumables, tools and agreed rates. Additional work rates and 'part thereof' clause.

WAREHOUSING SERVICES
Standard rates per month with agreed floor area in respective station. Additional storage space recharges rates. Exclusion of part # list engines and APU's: insurance and loss clauses.

ADDITIONAL SUPPORT
T&M rates for out of scope services like maintenance planning document (MPD), service bulletins (SB) and non-routine tasks.

GROUND EQUIPMENT SUPPORT
Charge at standard and part thereof rates for agreed units of measurement (per service, per event, per hour) for equipment such as GPU (ground power unit), air starter unit, push back, a/c unit, nitrogen cart, lavatory service, potable water service, etc. Inclusion clause as part of fixed price package and 'part thereof' rates to be recharged to the carrier.

MATERIALS SUPPORT
Charge a standard mark-up percentage for consumables and expendables provided by MRO contractor. Inclusion clause for consumables in fixed price package or recharged to carrier.