AVIATION WEEK MRO LATIN AMERICA

Hangar of the Future 2030

Challenges for MRO, Aerospace and Aviation Education

Presented by: The Colombia-Purdue Aviation & Aerospace Network of Excellence

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Colombia-Purdue Network of Excellence

NOE international collaboration: 2017 - Present

- Strengthen aviation education and research partnership opportunities
- Advance the body of knowledge – Sustainability needs for the industry

Colombia → Greater Latin American region → Global impact

Degree programs, **applied research**, professional development programs, collaboration and engagement activities.

Summer 2019 Discussions and Research Question:

Drivers challenging the workforce:

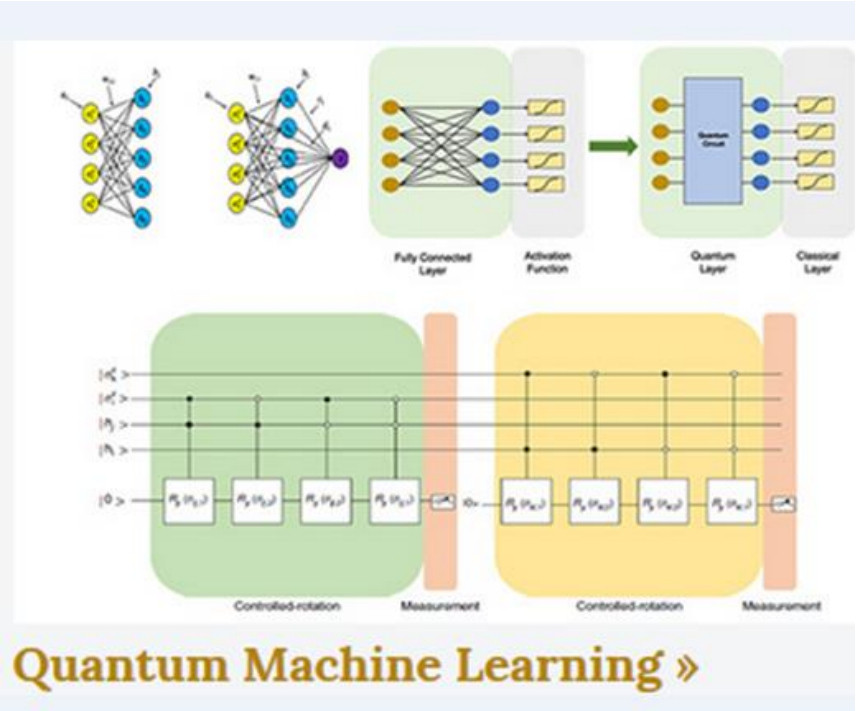
- New generation "smart" connected aircraft – Networked ecosystem
- More maintenance performed on-wing
- Current upgraded fleet types = lower initial trend in MRO volumes (newe
  + longer maintenance intervals) until around 2030
- Composites and other exotic material inspection, specialized repairs
- Quantum Computing*

How to keep critical MRO skills current during dwell times?

Key areas to evaluate:

- Disruptive technologies to adapt to? What issues in linking new and legacy systems?
- ***Resilient workforce***: What technical and competency needs for the future?

Mobile / Integrated Computing



(https://www.purdue.edu/discoverypark/quantum/#research.. Prof. Sabre Kais Purdue Quantum Science & Engineering Institute

Quantum Computer Algorithm

Start
All task requirements
identify all relationships for tasks competitions
coordinate relationships & tasks timing
create predictive non-routine
formulate non-routine probabilities into task schedule
establish safety risk factors
identify critical and non-critical activities
perform best work flow sequence and integrate relationships (traveling salesman model)
Constant update in real time during maintenance visit

Airframe MRO

Cost = ~ 70 % labor
MRO Return = contract charge $ – labor cost $
Key - Efficiency in reduce aircraft visit time

Predictive maintenance, on-wing/on-airframe assessment, reduced routing and hangar time

Derber, A. (2019)

Hangar of the Future R&D at Purdue

Vision: Infuse students' certification/degree skills with 'agile' research, data science, problem-solving and innovation competencies

Mission: Equip and produce a resilient aviation workforce to meet disruptive waves of advancement, challenging:

Safety, Efficiency, Reliability, Sustainability

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Challenges for MRO, Aerospace and Aviation Education

Human-Centered technology innovation in Aviation and Aerospace:

IIoT, Big Data, Augmented Reality, AI vs. Automation, Digital Twins, Adv. Mfg, AutoID, UAS/UGV and more…

Rapid, agile R&D, mid-level innovation

Industry driven: Needs drive the research focus and methods

- Steering and project partnerships with industry
- Point-of-operation: Technology serves the human
- TRL capabilities – Real world utility

<HOF AR / 3D Graphics Sample>

Research Design: Purdue IRB# 2019-176

Cross-sectional questionnaire (Qualtrics survey).
MRO and Aerospace Mfg. industry perspectives & vision on:

- **Technology adoption and readiness**
- **Workforce skills and competencies**

Goal:

Implications and a sight picture for focus: Adaptive, collaborative roles for **Aviation Education**, **Industry** and **Government/Regulatory**

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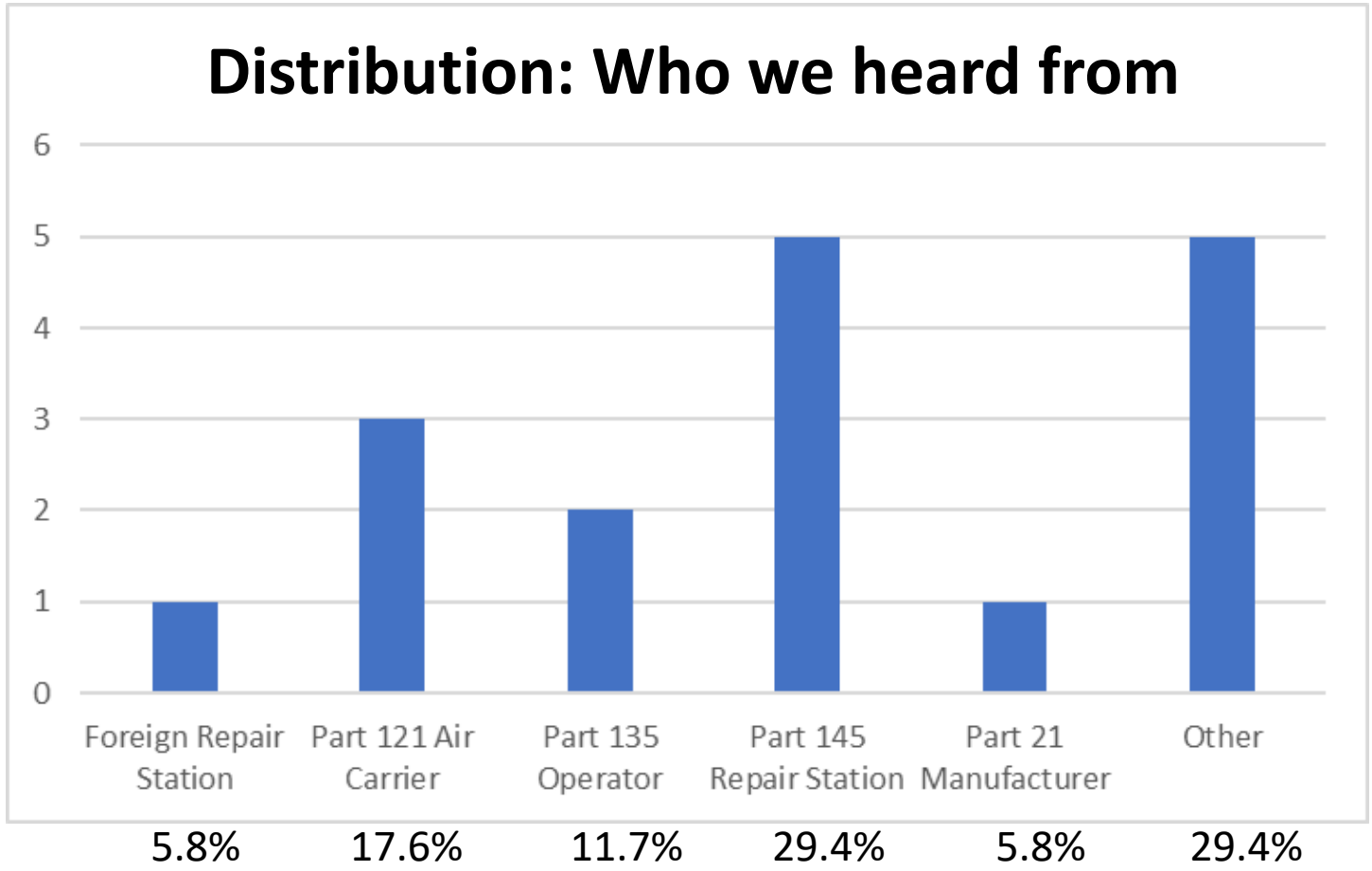
Challenges for MRO, Aerospace and Aviation Education

- Distribution: 205 recipients - MRO & Aerospace Mfgs.
- N = 107 66 (Colombia) 41 (U.S.)
- Data screening yield: 84
- Qualitative Responses: researcher ranking and consensus
- Quantitative Responses: Likert-style using average imputation calculation (Kelley, et al., 2003; Shafer & Graham, 2002) for item / non-responses



NOE Survey Data Results

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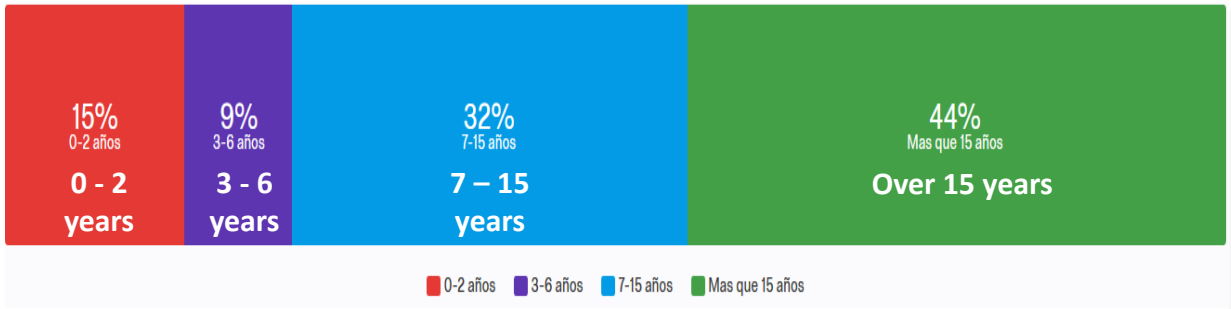
Challenges for MRO, Aerospace and Aviation Education

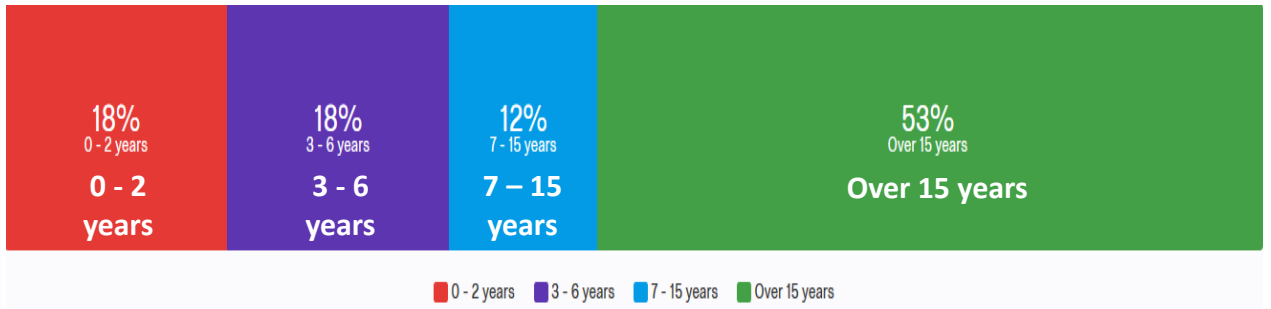
Experience Levels

Colombia



- Specifically in Colombia, aviation is not a temporary job. Most technicians take aviation maintenance as a life career.
- A large proportion of the current workforce comprised of retired technician personnel from Military Forces and Police.
- Management positions are scarcer, so competition is higher.

U.S.



- U.S. Median age lower 50's (US Bureau of Labor Statistics/ Oliver Wyman, 2017)
- Retention issues: Younger A&P graduates go to other technical industries (ATEC, 2019) https://www.atec-amt.org/news/category/workforce
- Retirement issues: Large segment of experiences AMTs eligible to retire in 2027
- Loss of mentoring and experience for new workforce AMTs

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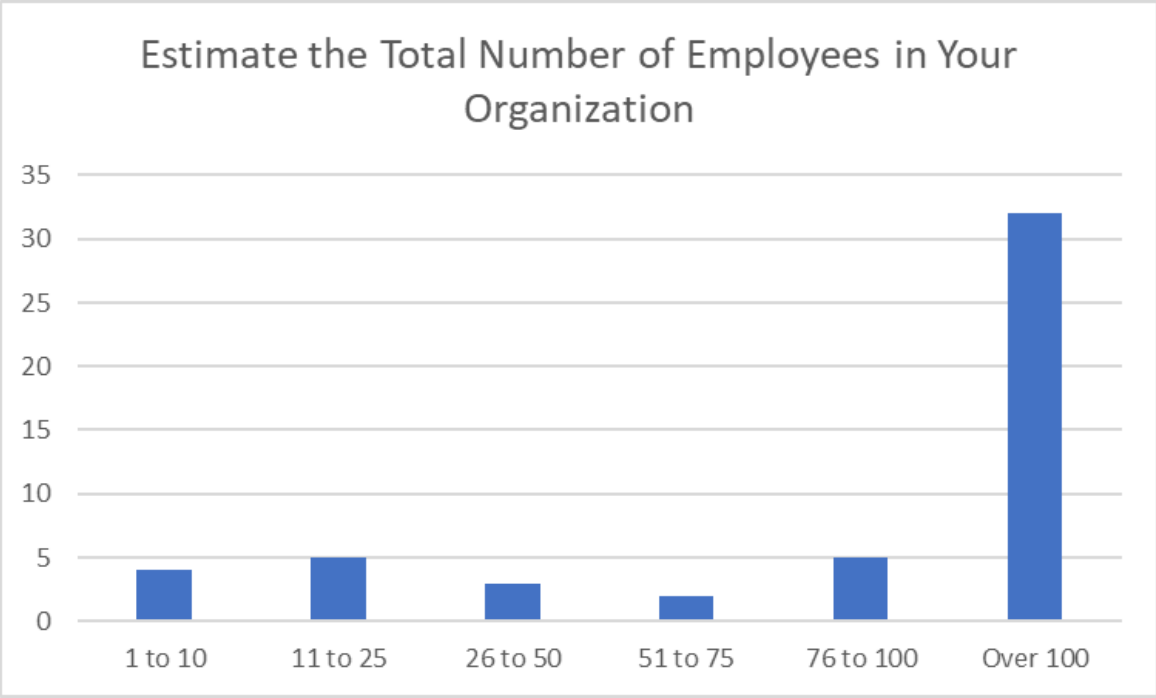
Challenges for MRO, Aerospace and Aviation Education



According to the Special Administrative Unit of Civil Aviation (UAEAC) today:

- There are 91 Authorized Repair Shops (TAR) in Colombia.
- 54 training centers for aviation (pilots and technicians).

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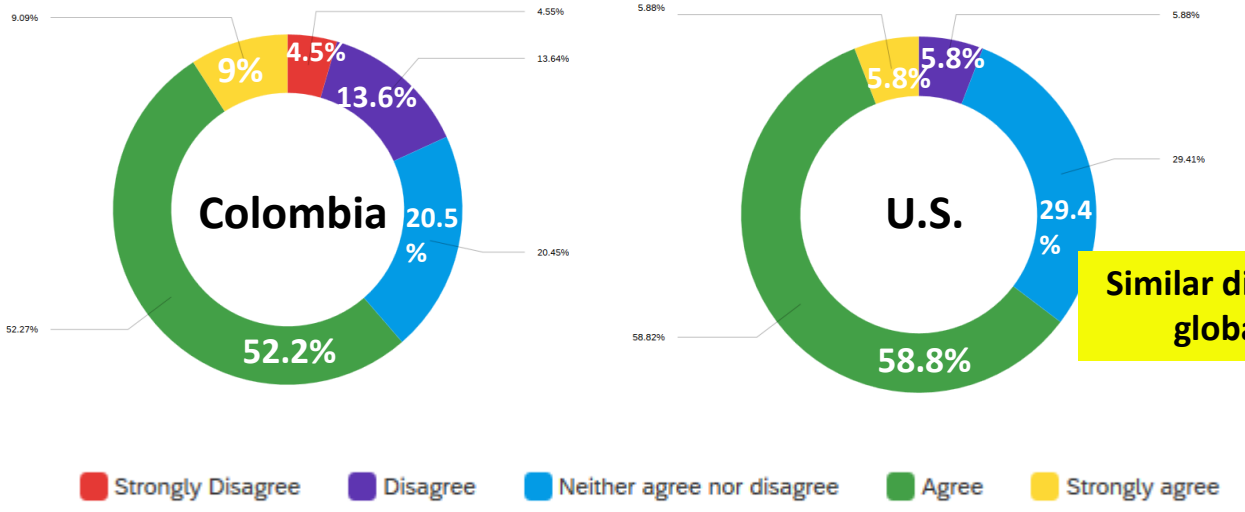
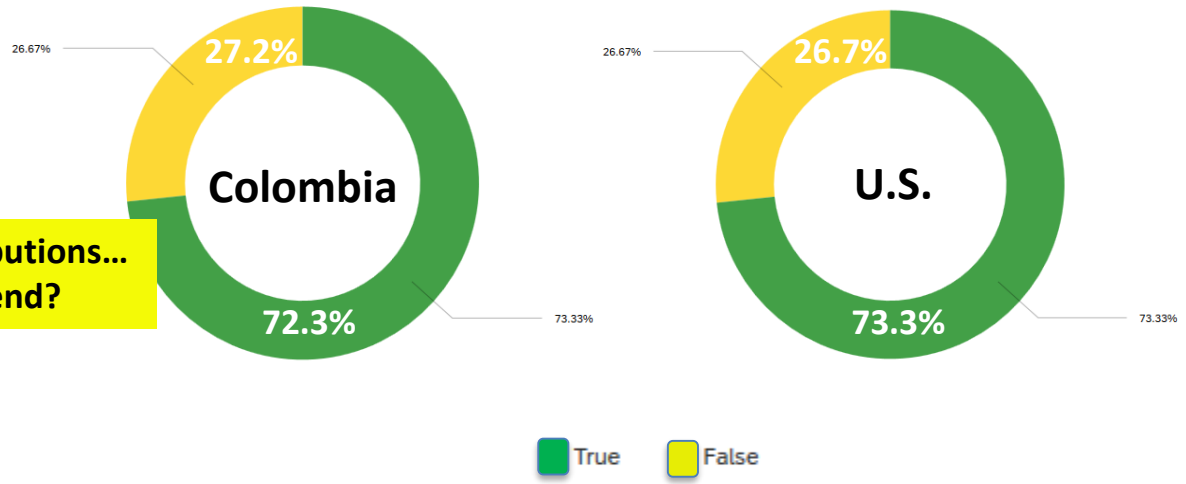
Challenges for MRO, Aerospace and Aviation Education

Current A&P certificate requirements adequately prepare new A&Ps to enter the workforce.



Similar distributions… global trend?

Newly certificated A&Ps have proper level of training to perform airworthy maintenance.



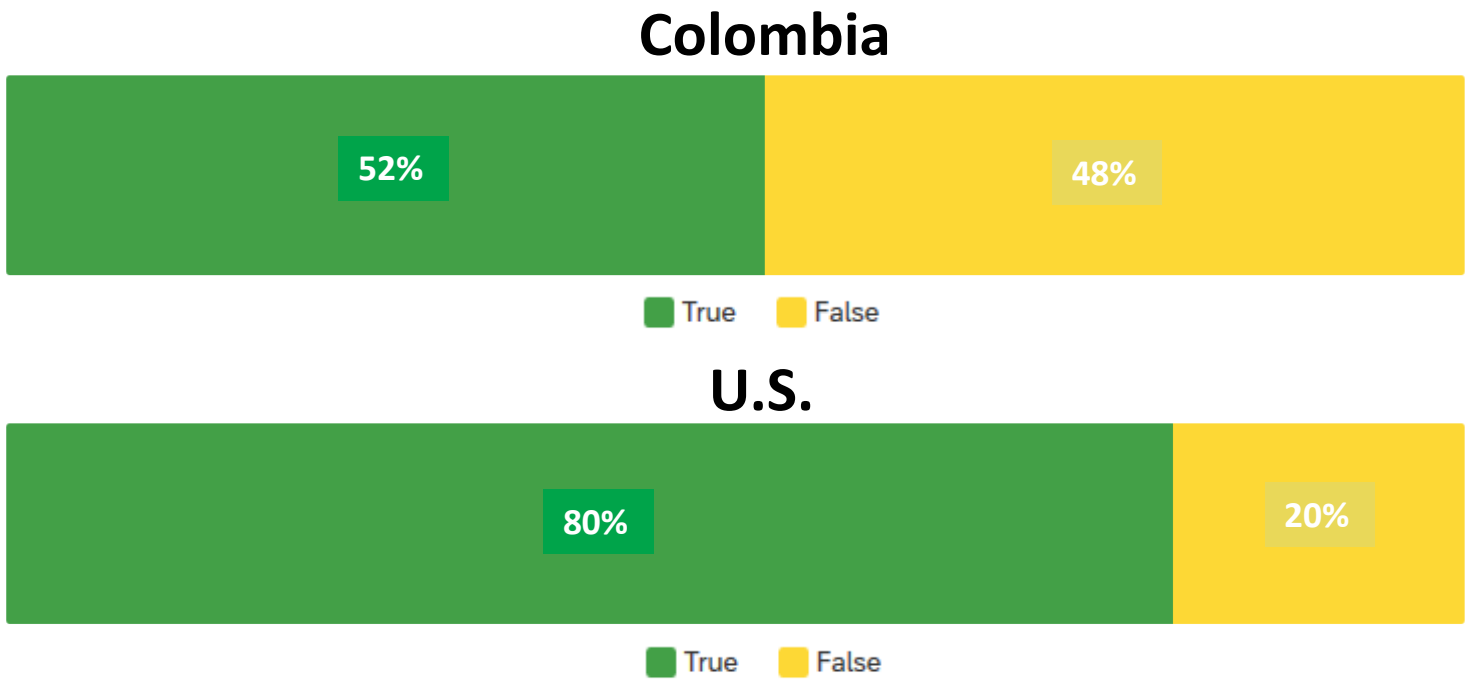
For further Discussion: Is there a need for changes in A&P training/educational programs?

- Management policies (MRO/Aero business drivers Continuous improvement, Problem solving)
- Different processes and perspectives (Air carrier, OEM)
- Computer, collaboration and communication skills

For further discussion: Experience gap? Is there a need to update in-house training experiences to reduce the gap?

- Enhanced OJT/Mentoring methods
- Focused training on Standard Practices, local maintenance aviation regulations
- Use of mobile and on-demand learning technologies (VR/AR)?

For the work we do right now, technicians have sufficient technical skills.



What are the most important technologies right now technicians should become more familiar with?

Word cloud display of most common terms (Colombia / US combined)

<u>Specific technologies and skills reported</u>:

- Digital and electronic tools (Digital display torque wrenches, micrometers, Boros) VR and AR tech.
- Design and manufacturing: CAD, CNC, CAM, Slitter
- Computer and software skills (ERP-SAP, computer maintenance tracking systems and automated inspection technologies)
- 3D printing/Additive Mfg. and specialized tools
- Metrology (electronic and laser tools)
- Composite materials scanning and repair
- Engines Overhauling
- NDI techniques
- Management (PLM)

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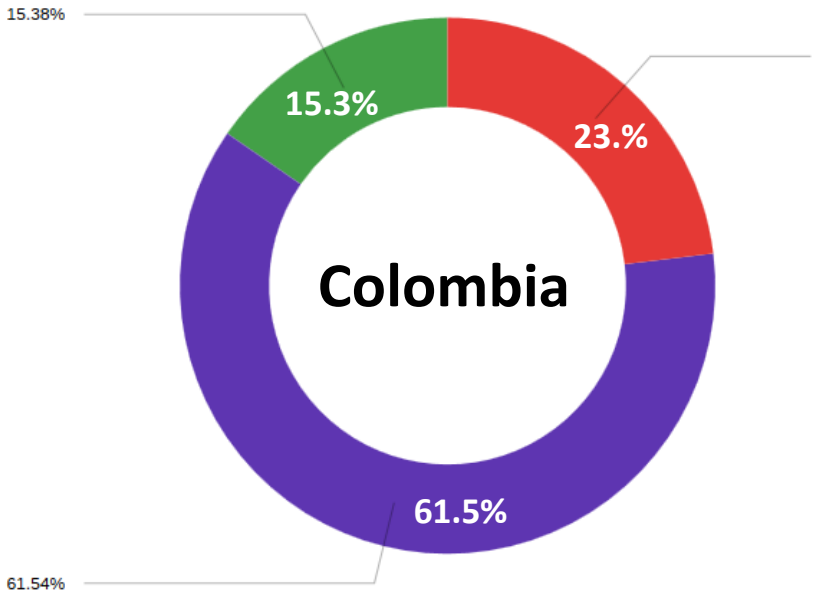
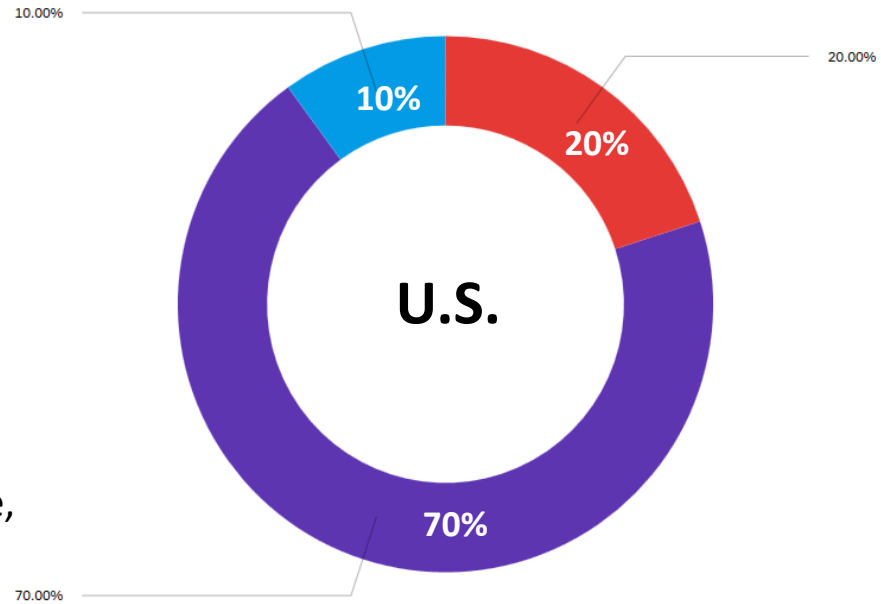
Challenges for MRO, Aerospace and Aviation Education

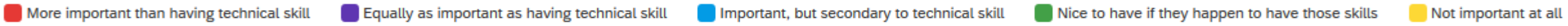
For a New Hire technician, people, team and problem solving skills are:



<u>Desired attributes reported</u>:

- Data analysis, Technical Manuals and AD/SB interpretation, Troubleshooting
- Willingness to change
- Continuous improvement mindset
- Teamwork, leadership and pressure management
- Communication skills (assertive communication, Emotional Intelligence, negotiation)
- Computer-assisted decision making (Excel, Power BI)
- ***<u>Training Retention (OJT & Recurrent)</u>**





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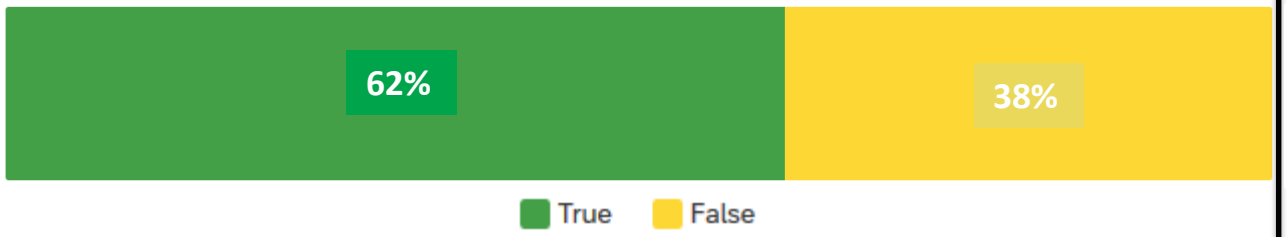
Challenges for MRO, Aerospace and Aviation Education

Most organizations reported having training on people, team and problem solving

(but less confident of the strength and transfer of that training)

Colombia



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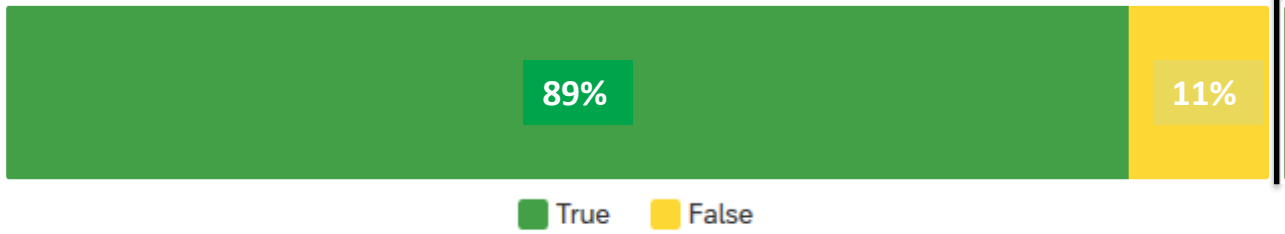
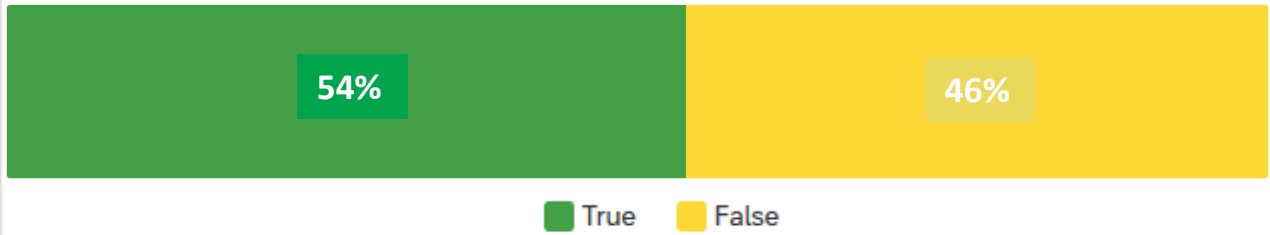


Most have training, but is it effective?

Organizations reporting workers have sufficient people, team and problem solving skills

Colombia



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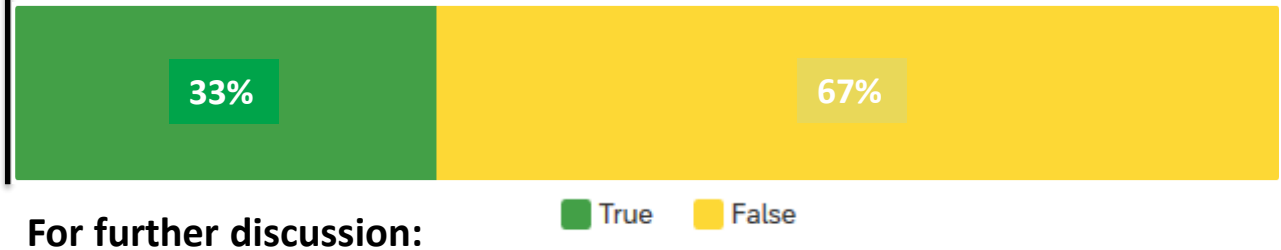

For further discussion:

Is training given to the right personnel?

Should training content be reviewed?

Is an organizational culture issue diminishing training effectiveness?

AVIATION WEEK NETWORK

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Challenges for MRO, Aerospace and Aviation Education

Workers attributes / skills for next 5-10Y

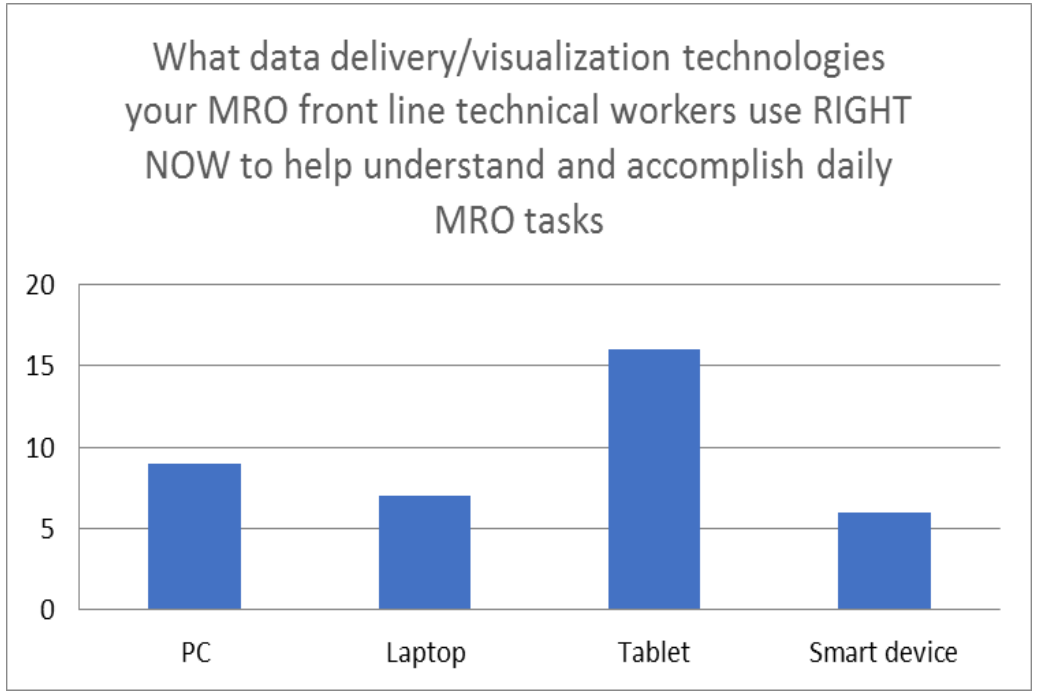
Weighted score matrix

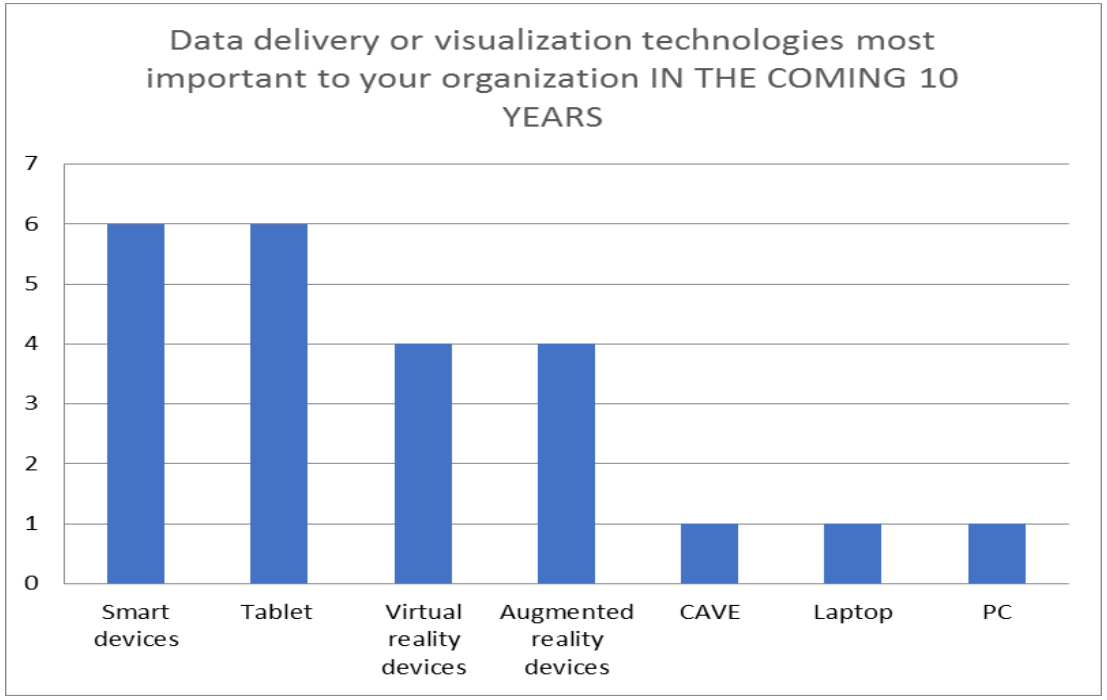
Beginning with the number 1 as the most important, please rank in order how important the following attributes will be for front line workers in your specific operation in the next 5-10 years.	Score										Total Score
Rank	1		2		3		4		5		
Value	5	Pts	4	Pts	3	Pts	2	Pts	1	Pts	
Open to continuously learning new skills	13	65	9	36	6	18	0	0	3	3	122
Finding ways to adapt to new ways of doing things into existing ways/innovation	12	60	9	36	5	15	3	6	2	2	119
Use problem solving methods to troubleshoot process or technical issues.	1	5	6	24	10	30	12	24	2	2	85
Able to form professional relationships with other workers.	3	15	5	20	9	27	6	12	8	8	82
Being self-directed to initiate discussions or act on problems on their own.	2	10	2	8	1	3	10	20	16	16	57

Reported tool/equipment-based technologies :

- Data collection analysis.
- Metrology (electronic sensors and scanners).
- NDI / NDT
- Sensors implementations on aircraft (Predictive maintenance)
- Artificial Intelligence.
- Automation.
- FADEC
- Machines programming.
- VR and AR
- Intelligent materials
- New manufacturing processes (3D Printing, CNC, simulation, finite element stress analysis).
- New maintenance processes (troubleshooting scanners, robotic inspection, simulation).

Data delivery / visualization tech





Assessment:
Portability will be important
Projected visual data take an important place among the consolidated technologies
Computers (even portables) lose participation

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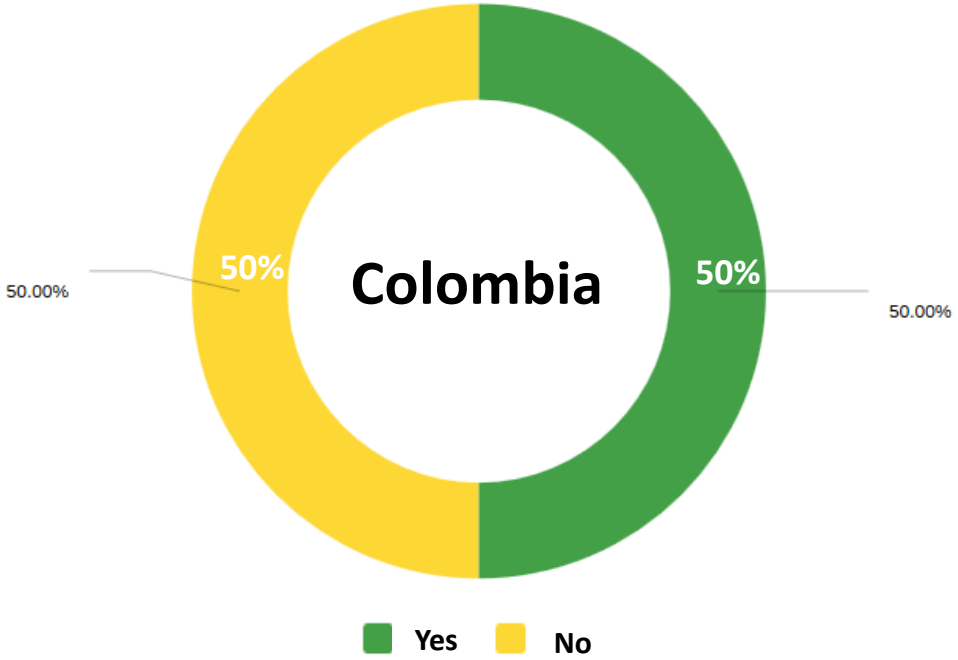
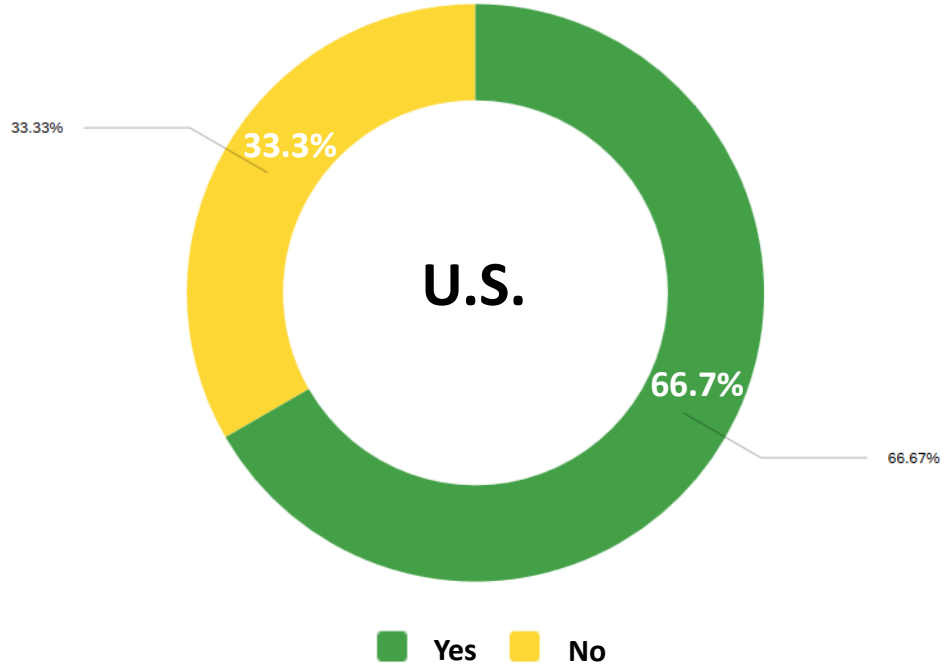
Challenges for MRO, Aerospace and Aviation Education

Are state of the art tools and technology currently being used/integrated with work tasks?



Common reasons for not using the tools and technology:

- Pragmatism
- Lack of training
- Fear of change
- Availability of those technologies
- Cost and resources to integrate into current processes



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Challenges for MRO, Aerospace and Aviation Education

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Universidad de Antioquia
CEO Cipsela Corporation

Traditional Manufacturing

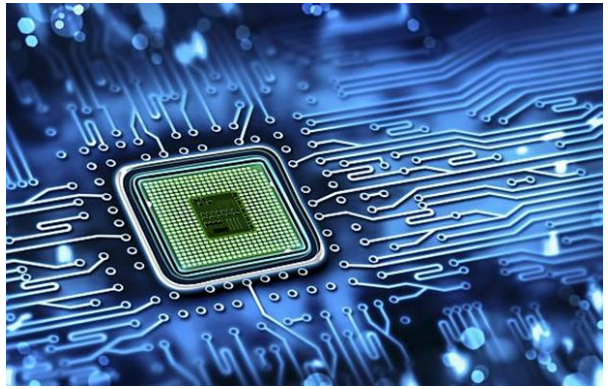
Subtractive

Deformative

Foundry

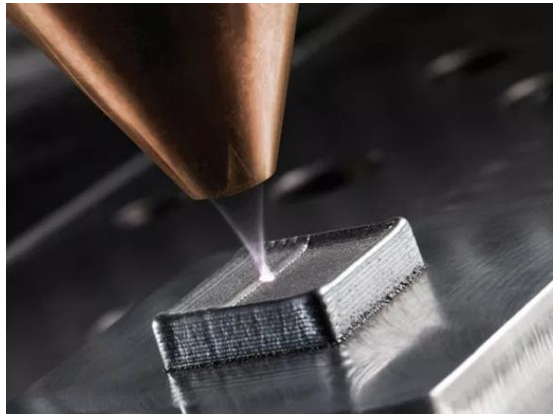
Welding

New Technologies



Microelectronics

Computer Science



Additive manufacturing

These technologies are revolutionizing the aviation and aerospace industries

In-house manufacturing and MRO

Based on Hangar Future outlook & survey/data

What changes and developments in education and training methods will be needed for preparing the NextGen technician?

- In 2030 there will be delivered a new generation of aircraft. We need new methods and values for training… Produce an equipped and capable workforce (re-skilling/updated training)

How will these changes line-up with certification requirements?

- The pace of industry is not the same of government agencies (this is a big challenge)

Challenges in education

Technicians and engineers should be trained in colleges and tech institutes with a “hands on experience” approach that incorporates training in:

- New methods of fabrication.
- Microelectronics.
- Computer and data science.
- Integration of new technologies not only for on wing or heavy MRO manteinance but fabrication.

New generation airplanes are very reliable but very complex. Handling a complex system requires deep understanding of the subsystems, once the system has a problem, lack of understanding can contribute to catastropic events

Critical needs:

- More flight science training: e.g. aerodynamics, control systems, command and data handling.
- Culture of communication between mantenance teams and team work.
- More indepth understanding of ground support equipment and procedures (the broad picture) even if it is not the specific area of the technician.

Challenges in government agencies

- Regulatory agencies should understand the pace of technology is very fast. For a healthy aviation and aerospace industry it is necessary to approve and regulate new methods of training in tune with new technologies. This not only applies for commercial aviation but other aerospace áreas (e.g. UAS).

- New methods in the processes of Certification. Example: Fast data analysis, permanent technology surveys to keep updated on regulations and topics for training.

- Regulations based on old technologies is a problem impacting efficiency, Cost and profits and most importantly airworthiness.

- Working closely with colleges, tech. institutes and industry players establish better communication to keep updated on regulated training topics and methodologies. Many regulations are established based on very old, even abandoned technologies. This is a big challenge in the Latin America case.

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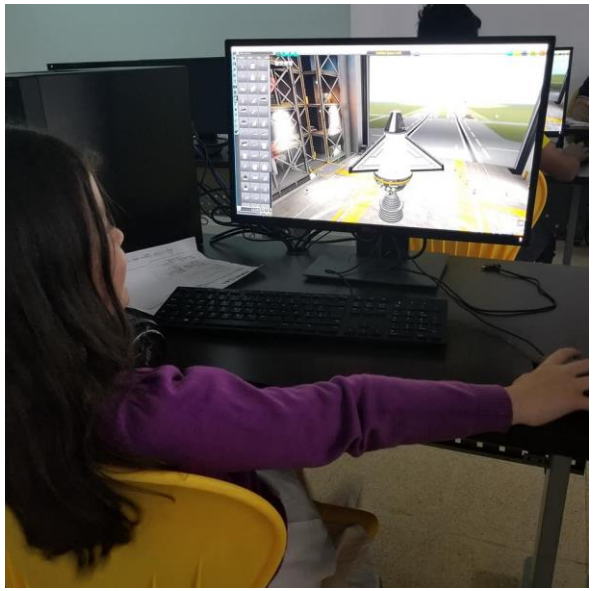
Challenges for MRO, Aerospace and Aviation Education

Education for NextGen technicians and engineers must start now - the 2030s are just 10 years away! We need STEM/STEAM programs focused in aviation and aerospace to inspire an upcoming workforce to implement the new technologies. We need a lot of people working effectively on aviation for the next decade!



Summary, and our vision for Next Steps

- We need decision makers informed about the new technologies in aviation and aerospace, the opportunity this sector represents for local and national economies, the need of more aviation and technology trained personnel inside the agencies. Government agencies should understand the industry will migrate to other countries/regions if it does not find the people or conditions to be competitive.

- We need the industry have a close collaboration with colleges and government. In Latin America at the end the industry has the pace of the technology. Governments and colleges can be slower to evolve.

- The NOE big challenge: Improve collaboration among these groups to work more effectively together to take advantage of new technologies and approaches and create a solid vision for our country for 2030 and beyond.

Summary

Mobile / Integrated Computing - Transitioning Processes

- Portability. Projected/Visual information take an important place among the consolidated technologies.
  * Current scanning technologies frequently mentioned (surface defect, point-of-maintenance 3D modeling and dent evaluation technologies) (Canaday, H. & Bjerregaard, L., 2019 a,b, & c).

- Portable laptops gradually losing use in favor of tablet or wearable computing capabilities

- Cost and resources: integrating system upgrades (WIFI and other data delivery architecture capabilities), training, software upgrades

Continuous, Applied Learning

- More real maintenance practices
- Policy and procedure (continuous improvement)
- Local maintenance aviation regulations
- Different processes and perspectives (Air carrier vs. OEM)
- Computer skills (Big Data, AI, PbM)
- Collaboration and communication skills

Need for innovation, modern curriculums with emphasis on competencies (technical and otherwise) reflective of the technical advances in modern aircraft. (Maguire, 2019).

Evaluate existing training effectiveness

Training may exist, but might need modernized and targeted

- Update training content and objectives (data capture skills and tools, more composites)
- Identify who gets training
- Management/Organizational culture: open communication? Participative teams? Workforce involved in root cause and preventive processes?

Workforce Competencies

- Continuous learning; open to skills maintenance & re-skilling
- Adaptive, innovative
- Problem solving and troubleshooting (process and technical)

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Thank You!

Questions & Discussion

<Resource and Discussion Slides>

Key Questions

Evolving Technologies:

- How will mobile computing, 3D printing, Augmented & Virtual Reality, AutoID sensing be integrated into current maintenance processes?

  What key Airworthiness, Safety, Quality, Efficiency, ROI considerations?

Evolving Education & Training Practices:

- Key competencies demanded by industry: problem solving, innovation, continuous learning and skill retention (more than OJT?), reading technical data

  What changes in education practices to enhance graduates' readiness?

- How do these changes line-up with current regulatory certification requirements?

Evolving Industry and Government Roles:

- How can government agencies in Latin America enable change and transition for **Technology** and **Workforce readiness**?

  What stronger partnering roles to enhance the educational pipeline?

Key Questions

Evolving Technologies:

- How will mobile computing, 3D printing, Augmented & Virtual Reality, AutoID sensing be integrated into current maintenance processes?
  What key Airworthiness, Safety, Quality, Efficiency, ROI considerations?

Example:

Technology Drop-In Readiness Assessments:

- *Industry partner requirements* (supply chain & customer inputs & outputs)
  Access to Digital Thread for on-demand data: Design→Mfg. →In-service→End of life)

- *Organizational requirements*:

  5P Assessment: **People, Parts, Process, Procedures, Placement**
  Process Mapping
  Risk profile & mitigation

Key Questions

Evolving Education & Training Practices:

- Key competencies demanded by industry: problem solving, innovation, continuous learning and skill retention (more than OJT?), reading technical data
  What changes in education practices to enhance graduates' readiness?
- How do these changes line-up with current regulatory certification requirements?

Example:

Mentoring Aerospace and Aviation MRO Workforce Competencies

Industry:

- Participative teams: Engage in the basics of business (process mapping, RCA/PHA, other BI for the front line)
- Tune current in-house training and mentoring

Academia: (A&P)

- Integrate principles of resilience through problem-based learning curriculum; agile R&D
- Data science

Key Questions

Evolving Industry and Government Roles:

- How can government agencies in Latin America enable change and transition for **Technology** and **Workforce readiness**?

  What stronger partnering roles to enhance the educational pipeline?

Apprenticeship Core Elements (Maguire/ATEC, 2019)

- **Paid job** – apprentices paid allowing to "earn and learn"
- **Work-based learning** – Learning model based on time engaging in job, gaining and demonstrating skill competency or a hybrid
- **Classroom Learning** – Training/Educational partner (community college, Online or in-house)
- **Mentorship** – Internal mentoring one-to-one support for apprentices
- **Credentialing** – Industry recognized credential/cert issued on completion

Source: U.S. Dept. of Labor: https://www.apprenticeship.gov/employers/create-program

Survey development: Purdue IRB# 2019-176

- Cross-sectional questionnaire - *ranked* and *open-ended* response
- Sampling of aviation and aerospace organizations (Latin America and US)

  - Adapted previous aviation workforce survey instrument (Lercel, et al., 2015) and industry competency listings (U.S. Dept. of Labor, FAA)
  - Validation cycle: two forward/back cycles (translation, cultural/contextual language)
    Purdue International Programs review
    Colombia NOE partners
  - Piloted to 6 MRO and 2 aerospace Manager/Director level

References

Canaday, H. & Bjerregaard, L., (2019a). How Digital Workforce Tools Are Transforming MRO Strategies. *MRO Network.com – Inside MRO*, Dec. 5, 2019. Interview with CEO Arun Chhabra, 8Tree – 8Tree's DentCheck. Retrieved Dec. 12, 2019 Available: https://www.mro-network.com/emerging-technology/how-digital-workforce-tools-are-transforming-mro-strategies-0

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