Redesigning Air Traffic Control Towers For the Future

MANUEL HERRERA
Jacobsen|Daniels

CHRIS GROH
Kutchins & Groh
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PRESENTATION GOAL

The Air Traffic Control (ATC) System is one of the fundamental cornerstones of aviation.

With the rising costs associated with construction, building code compliance, technology updates, labor union agreements, etc., maintaining the current Air Traffic Control (ATC) system is simply impractical.

As the industry continues to grow and incorporate more technology, the evolution of ATC is inevitable. Today, both the public and private sectors are working to push ATC into the future, making it more efficient and safer.

However, today’s proposed solutions and concepts are still falling short. Rather than working towards a newly reinvented ATC system using technology as a fundamental building block, today’s concepts simply place technology on top of the existing system. This “solution” is not only increasing the complexity of ATC, but it’s also increasing its overall cost.
The current trajectory of today’s future concepts will still leave the ATC system vulnerable to the most common weak point in almost every industry: **human error**.

This presentation will show the potential of going beyond the currently proposed industry solutions and how a completely **unmanned air traffic control (UATC) system** could be implemented. We’ll address the financial and safety benefits, as well as potential roadblocks, and why this idea isn’t out of the realm of possibility.

We’ll also evaluate the current system, the challenges it’s facing, and the solutions proposed by the industry.
The term “innovation” has recently become a buzzword in almost every industry to try to describe a “forward thinking” company or product. It has become synonymous with ping pong tables, beanbag chairs, and offices with no walls.

However, innovation does not happen overnight and it is not singular to one industry or product. Innovation is an evolutionary process that results from taking an already existing product or process, incorporating a new discovery or process, and iterating the original concept to improve overall efficiency.

A great example of this today, and parallel to the idea of an unmanned air traffic control system, is the inevitable path of the automobile towards autonomy, starting with its invention through cruise control to today.
The auto industry is an example of an industry that is currently going through significant changes and challenges in implementing automation.\textsuperscript{2} Despite the resistance or limitations from special interest, legislation, or markets, full automation is inevitable.

**AUTONOMOUS CAR MILESTONES**

- **Car Invented**
- **Initial Tasks** [Parallel park, cruise control, etc.]
- **Initial Semi-Autonomous Features** [Tesla’s Autopilot, etc.]
- **Semi-Autonomous Features on All Vehicles**
- **Mixed-Fleet on Roadways**
- **100% Automation/Restricted Manual Driving**

Today
Similar to the driving forces that support automation in vehicular traffic in our roads, current air traffic relies on a complex system of procedures that passes an aircraft from one facility to the next, each with its own set of parameters and challenges (e.g., intersection-to-intersection for vehicle traffic).³
CURRENT ATC SYSTEM

On one flight from BWI to LAX, a pilot could end up communicating with up to: 4

28 Controllers
11 Facilities across the country

This cumbersome system is overburdened and will not be sustainable to meet the industry’s future growth. Also, as unmanned aerial vehicles (UAV) usage increases over the years, this system will be ineffective.
CURRENT SYSTEM: MAJOR ISSUES

Today’s system faces 2 immediate and major breaking points:

1. **COSTS**
   - This issue is a threefold and encompasses the costs of maintaining the existing infrastructure, updating the old technology, and building new and/or updating existing towers to meet State & Federal compliances.

2. **LABOR**
   - According to the National Air Traffic Controllers Association (NATCA), the number of Air Traffic Controllers is at a 27-year low.\(^5\)
CURRENT SYSTEM: COST ISSUES

“Many of FAA’s air traffic control facilities have exceeded their useful lives, and their physical condition continues to deteriorate.”

2008 OIG REPORT
FAA’S MANAGEMENT AND MAINTENANCE OF AIR TRAFFIC CONTROL FACILITIES

BY THE NUMBERS:

Today’s ATC system is plagued with a deteriorating infrastructure and facilities that are exceedingly past their expected useful life.

Facilities Expected Useful Life: 25 - 30 Yrs.
Average Age of Tracon Facility: Approx. 35 Yrs.
Average Age of En Route Center: Approx. 50 Yrs.

A 2015 US DOT OIG report estimated the FAA spends $142 Million Annually just to maintain and operated inefficient towers.
CURRENT SYSTEM: COST ISSUES

Recently San Francisco International (SFO) & McCarran International Airport (LAS) in Las Vegas completed construction on new ATC towers.

Those towers cost:

SFO: $77 Million
LAS: $100 Million

These figures do not include costs to demolish existing towers.

Also, once these towers were nearing completion - it was discovered there was no room made for the historic “paper strip” system. This system involved controllers to literally pass along paper strips to track aircraft.\(^8\)
CURRENT SYSTEM: LABOR ISSUES

By The Numbers:

70,000 Flights Handled Daily

134 Million Operations Handled in 2015

3,355 Controllers Eligible for Retirement

1,959 Developmental Controllers

$93,000 Annual Costs Per ATC Trainee
CURRENT SYSTEM: LABOR ISSUES

“We are required to work all sorts of hours: day or night, holidays, weekends, during our kids’ concerts, during family gatherings, etc. If we aren’t feeling well, we can’t just take an over-the-counter antihistamine without consulting the flight surgeon and potentially losing our medical. You can’t just put some work aside to do tomorrow — if something needs to be done, it needs to be done, and usually right now.”

- SCOTT SHELERUD
26 YEARS EXPERIENCE
FAA Tower Controller

INDUSTRY IMPACT:

As of Aug. 15, 2016, the FAA says 29,000 applicants have applied for the 1,400 positions. However, even if all those air traffic controllers are hired tomorrow, experts estimate it will take an additional 1,500 controllers to maintain adequate staffing and keep up with retirements.

Staffing at Selected TRACON Facilities:

- New York: 60.1%
- Dallas: 61.3%
- Atlanta: 69.1%
- Denver: 73%

Staffing at Selected Airport Towers:

- ORD: 76.5% (875,136 Ops.)
- MSY: 75% (104,623 Ops.)
- MIA: 67.5% (412,915 Ops.)
The problems facing the industry have been anticipated by Federal Government and the supported trade groups. While most OIG reports recommend further studies, the NATCA has developed definite solutions.

The recommendations from their website include:

1. Streamline the hiring process by ensuring a path for experienced controllers to be hired quickly and allow military veterans and graduates of schools in the FAA's Collegiate Training Initiative (CTI) to be hired more expeditiously.

2. Maximize the capacity of the FAA Academy in Oklahoma City.

3. An FAA controller vacancy announcement for experienced controllers that is open and continuously maintained 365 days per year.


5. Stable, predictable funding for the FAA, including ensuring that the FAA is not subject to future sequester cuts.
While the NATCA recommendations would solve some of the issues facing the nation’s ATC, each recommendation would require the FAA to receive additional federal funding to increase its overall budget.

Unfortunately, the reality of these recommendations rely on the attitude of Congress during any given year. This is not a feasible or sustainable strategy.
An unmanned air traffic control (UATC) system is a system in which aircrafts communicate with other aircrafts, as well as other various sensors, to receive pertinent information throughout the various stages of flight. The information and data collected by the various aircraft and related sensors would be fed into computers (whether onboard an aircraft or located at an airport), interpreted through Artificial Intelligence (AI), and sent as related instructions to pilots. The data gathered from these sensors would include:

- Aircraft Location
- Aircraft Speed
- Weather Conditions
- Location of Surrounding Aircraft
- Flying Conditions at Various Altitudes
- Ground Traffic at Departing/Arriving Airports

A system designed to gather data directly from the source and report to pilots with minimal human intervention will provide a more reliable, safer, and less costly future.
An unmanned air traffic control system relies on various types of communication depending upon the situation.

While a future with a UATC system seems far-fetched, pieces of this puzzle are already being put in place throughout various sections of the current system. With the right planning and implementation, this is a very feasible future.
The Next Generation Air Transportation System (NextGen) is the FAA’s new National Airspace System initiative that was started in 2003 and is expected to be fully implemented by 2025.

The new system involves every aspect of US Aviation and consists of 4 elements:

1. **Automatic dependent surveillance—broadcast (ADS-B):** ADS-B will use GPS satellite signals to provide air traffic controllers and pilots with much more accurate information that will help to keep aircraft safely separated in the sky and on runways.

2. **Next Generation Data Communications (Data Comm):** Data Comm will enable ATC to issue route information with one transmission to the aircraft’s flight management system.

3. **Next Generation Network Enabled Weather (NNEW):** NNEW will provide a common weather picture across the national airspace system, and enable better air transportation decision making.

4. **National Airspace System Voice Switch (NVS):** NVS will replace current voice systems with a single air/ground and ground/ground voice communications system.
In 2013, Saab, the Swedish aerospace and defence company, installed their first remote air traffic control tower at Örnsköldsvik Airport in Sweden.

According to Saab, “the Saab Remote Tower system is an integrated package of subsystems which facilitates the provision of a range of conventional ATS. High definition images and all relevant airport systems are transferred via a data network to an integrated controller working position at the Remote Tower Centre (RTC) that best suits the customer’s business model.”

This system is designed to replace manned towers and allow air traffic controllers to remotely monitor an airfield. It can also allow for controllers to monitor multiple low-traffic airports.

Remote towers offer a lower-cost solution for airports that would not otherwise be able to afford an ATC or update/upgrade current ATC services.
With the implementation of NextGen and industry manufacturers incorporating more “smart” and trackable technology into the aircraft of the future, the cockpit would easily be able to record, receive, send, and interpret data while in flight.

In addition to the multitude of sensors being placed on-board, one of the biggest contributors to the future of UATC will be the ability of controllers to send flight route information via on-screen text.

The immediate benefit of receiving flight information and directions via text is this will free up voice channels for emergency response situations. It will also reduce confusion or misinterpreted directions caused by radio static or regional accents.

These advances in the industry are “on their own” going to change the way we fly. However, as these advances are looked at as puzzle pieces to the future, the connection between them and how they can lead to a UATC system becomes more apparent.
The adoption of NextGen will set all the initial pieces and sensors in place to move to a full UATC system. The data collected from systems like ADS-B and NNEW will be integral to providing a UATC system with a real-time picture of any aircraft’s current situation. It will also eliminate antiquated communications systems that were built on top of each other and centralize them into one modern system.

These new technologies and updated processes will allow for a more comfortable introduction and seamless integration of a UATC system with pilots and the general public.

At its basic core, a UATC system - working within the NextGen system - will remove the need for a human to collect, interpret, and communicate data back to pilots. This in turn will provide a clearer and safer picture of a pilot’s surroundings and drastically cut down on the expense of ATC while improving its efficiency.
Flight route information and directions via text messages, as mentioned earlier, will have great immediate benefits. However, in terms of a UATC system, one of the greatest benefits is that it will condition pilots to receive this information without hearing it from a person. This will make the adoption of a UATC system seamless for pilots, since the human element will have already been removed.

It will also allow for traffic control directions to be translated into any language, which will reduce the language barrier of becoming a pilot and open the career to more of the world’s population.
Remote Towers will introduce and condition pilots to get comfortable with the idea of taking directions from controllers who are not physically present on the airfield.

Also, remote towers, combined with sending instructions via text messages, will create data sets that can be processed through artificial intelligence (AI) so the system can learn pilot and controller tendencies, as well their responses to certain situations. By collecting data from different airports across the country through a cloud network, the AI can continuously learn and compare results from an almost infinite amount of scenarios. This will allow the system to become smarter and better equipped to handle situations without the hazard of being overworked, sick, or distracted.

Through the collection of data, learning of human tendency/reactions, and analyzing different scenarios, the UATC system can evolve overtime. It will move from an observing role, to making recommendations, to communicating directions to pilots with controller oversight, and finally, full autonomy. The system would also be able to quickly and proactively self-adapt to changes in air traffic demand without costly investment in procedural, operational, or technology changes.
Similar to the autonomous car, this is not a process that happens overnight and certain milestones must be reached before moving on to the next. While some of these milestones will happen simultaneously, some will require a preceding milestone to help condition pilots and get them comfortable with a new method of communicating with ATC.

**UATC MILESTONES**

- **Beginning of Air Traffic Control**
- **Commitment & Development of the NextGen System**
- **Implementation of NextGen & Experimenting with Remote Towers**
- **Wider Adoption of Remote Towers & Allowing a UATC AI to Observe and Analyze Data**
- **Incorporating UATC AI into Remote Towers & Airfield Towers to Make Recommendations to Controllers**
- **Connecting the AI to Pilots in the Cockpit and Allow Directions to be Delivered with the Monitoring of a Controller**
- **100% Unmanned Air Traffic Control**
THE FUTURE: UATC

ROAD BLOCKS:

With any change comes resistance and this resistance is even stronger when entire industries evolve. As with any new and innovative idea, a plethora of issues can be called out from skeptics across industry. While in its infancy, the idea of an unmanned air traffic control system can bring up several issues - two of which can be addressed up front. Ironically, the two issues first brought up with an Unmanned Air Traffic Control system are in fact solutions to the two major issues the current system faces.

1. **Adapting Careers**: The issue that is most common with innovation is the potential, and probability of job loss.

2. **Investment**: As with any innovation, increased up-front costs is inevitable. However, a strategic cost up-front could result in a significant amount of saving in the long run.
Adapting Careers:

The most apparent issue with an unmanned air traffic control system is the concern for loss of jobs for Air Traffic Controllers. However, as previously proven, today’s current job market is not able to meet the demand for ATC’s needs and the pool of prospects is getting smaller.

Also, the fear of job loss is not a substantial reason to hold off society’s evolution, particularly because as society changes so do the needs of the industry along with the job roles needed to support it. The common example is the impact the automobile industry had on farriers and blacksmiths. However as the transportation industry shifted, the jobs shifted from horseshoe fabrication to mechanics, tire manufactures, etc. A more relevant industry example is to simply track the evolution of the navigator in the cockpit as aircraft got smarter.
The initial cost of development of an Unmanned Air Traffic Control system will undoubtedly be a big up-front expense. However through public-private partnerships (similar to those that solved a lot of the issues on the federal level that the healthcare.gov site experienced), these costs could be reduced.

Also, the cost of maintenance on any automated system over time is significantly more affordable than the cost of man hours - even more so when calculating in overtime, costs of training, and scheduling.
THE FUTURE: UATC

**Benefits:**

In addition to being a long-term sustainable solution to today’s ATC’s biggest pain points, an Unmanned Air Traffic Control system would drastically bring down the cost of scaling air traffic control to other airports. This cut to costs would allow smaller airports that serve general aviation operations to offer ATC services. As a whole, this will make the industry safer as it continues to grow.

Another big contribution of an UATC system is the ability to incorporate and manage Unmanned Aerial Vehicle activity. Today’s ATC has no way of being able to track UAV activity within regulated airspace (whether it be for commercial or personal). By having manufactures share already existing GPS data of active UAVs, a UATC system can safely notify both pilot and operator of each other and direct them safely.

Because of the expected increase in UAV activity of the next few years, this is something no current controller will be able to safely manage.
The concept of an Unmanned Air Traffic Control System is a revolutionary long-term idea. However, as technology evolves and people become more comfortable with computers handling more tasks, the evolution to this type of system will be more embraced.

Unfortunately, a timeline for this system is not easy to predict because the biggest roadblock to this system will be politics and special interest groups (labor unions, manufacturing and maintenance companies, etc.). This presentation did not address or make any assumptions regarding particular parties involved, because there are too many factors to assume. Also, the support for using technology differs when revenues are affected - whether that is increasing revenue by decreasing labor costs or decreasing revenue because of a decline in membership. These realities are a part of implementing an unmanned system and will inevitably be debated in Washington D.C. and across the country.

It is important to point out, however, that the FAA may currently be planning for this type of system and, because of political reasons, may not be able to announce a true long-term approach. The sensors and data that is called for through NextGen initiatives are directly in line with a hypothetically development strategy if the FAA was planning for such a system. Regardless, an evolution to a semi-autonomous system as a precursor to an autonomous system is inevitable and necessary to continue to have ATC serve as one of the fundamental cornerstones of future aviation.
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CYLE R. CANTRELL, C.M. & LEED GA
Manager of Aviation Services
Michael Baker International

Certifications:
- Certified Member, AAAE
- Green Associate, LEED

ROBERT F. TYKOSKI
Airfield/Airspace Planner
Seattle-Tacoma International Airport

Certifications:
- Certified Flight Instructor - Instrument Airplane, FAA
- Advanced Ground Instructor, FAA
- Commercial Pilot Certificate, FAA
- FAA-IDLE Level 3 AC 150/5300-17 - 150/5300-18, FAA
APPENDIX: SOURCES

1: The Inevitable: Understanding The 12 Technological Forces That Will Shape Our Future - Kevin Kelly, 2016

2: Recode: The complete timeline to self-driving cars
http://www.recode.net/2016/5/16/11635628/self-driving-autonomous-cars-timeline

3: National Air Traffic Controller Association: Where We Work

4: Federal Aviation Administration: Flight Across America
https://www.faa.gov/air_traffic/flight_across_america/

5: National Air Traffic Controller Association: June 15, 2016: Controller Staffing at a 27-Year Low; Rinaldi Tells House Aviation Subcommittee the Situation is a “Crisis”


7: Office of Inspector General: Efficiency of FAA’s Air Traffic Control Towers Ranges Widely
https://www.oig.dot.gov/library-item/32652

8: The Seattle Times: Union: No room for old technology in new airport towers

9: National Air Traffic Controller Association: Aviation Facts

10: Mashable: What’s it like to be an air traffic controller?
http://mashable.com/2015/05/21/air-traffic-controller-career-profile/#8dpQV_7j_SqZ

11: NBC Bay Area: Crisis in Air Traffic Control Towers

12: Federal Administration Aviation: NextGen Programs
https://www.faa.gov/nextgen/programs/

13: SAAB: Remote Tower - It’s a New Era in Air Traffic Control