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THESIS FINAL PAPER
In Air Traffic Control

NexTower Technology & implementation

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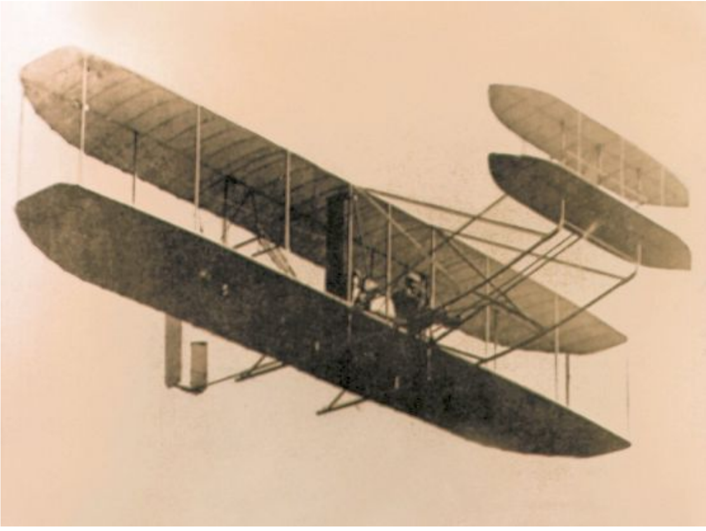
1 Historical introduction

The History of a flying vehicle, heavier than air, was born in 1903, when in North Carolina two brothers, Orville e Wilbur Wright, builds the first motorized flight named “Flyer 1”.



Wright’s Flyer 1

The Wright brothers’ vehicle was able to levitate for twelve seconds making a 36 meters long flight.

Later in time, during the Reims meeting (original name “La Grande Semain D’Aviation de la Champagne”), August 1909 , in France, aircraft became the leading actor of sportive events.

This event meant, for a few pioneers, the beginning of a technological competition which lasted for years, but the First World War erased every sportive use and the aircraft became only a war instrument.

At the end of the war was celebrated the first civil route : London-Paris ,for only one passenger and for postal packages, concept such as “air traffic flow” and “air traffic management” did not exist yet.

During the Second World War there was a massive use of warplanes and the aeronautical technology had an exponential development.

After the Second World War there was the necessity to increase the rapport between states and aircrafts were a powerful way to made distances closer. The air traffic had an important increase and the “Air Traffic Controller” (ATCO) professional figure was born.

In 1920, the Croydon Airport based in London was the first airport in the world to introduce the air traffic control. It was actually a wooden hut 4.6 meters high with windows on all four sides. It provided basic traffic, weather and location information to pilots.

Flight service stations do not issue yet control instructions, but provide pilots with many other flight related informational services.

First air traffic controlled airport

2 Airport traffic control tower

The first airport traffic control tower, regulating arrivals, departures and surface movement of aircraft at a specific airport, opened in Cleveland in 1930. Approach/departure control facilities were created after the adoption of the radar in the 1950s to monitor and control the busy airspace around larger airports.

About the concept of Airport traffic control tower, the primary method of controlling the immediate airport environment is the visual observation from the airport control tower. The tower is a tall, windowed structure located on the airport grounds. Air traffic controllers are responsible for the separation and efficient movement of aircrafts and vehicles operating on the taxiways and runways of the airport itself, and aircrafts in the air near the airport, generally 9 to 18 kilometers depending on the airport procedures.

3 Air Traffic Services (A.T.S.)

The services provided to air traffic, organized according to the ICAO directives, established for the purpose of providing the maximum possible assistance both to the individual aircraft and to all air traffic. These services can be simple flight informations, advices on air traffic, air traffic control and alarm. In particular, air traffic services aim to:

- **Prevent** aircraft collisions
- **Prevent** collisions between aircraft on the aerodrome maneuvering area and obstacles existing in that area
- **Accelerate and maintain** the flow of air traffic
- **Provide useful information** for safe and efficient flight conduction
- **Promptly inform** appropriate organizations about aircraft in danger or needy assistance and rescue and collaborate with such organizations as they request. To learn more about the concepts of air traffic management everybody can visit the beginners section of the association website. National Air Navigation Assistants and Controllers: http://www.anacna.it/

4 Major National & International Agencies

4.1 International Civil Aviation Organization

(official website: *http://www.icao.int/* **)**

The most important international organization in air navigation is the International Civil Aviation Organization

Main structure:

- Council (8Commissions)
- Assembly
- Secretariat

Purpose:

- **Safety**: from the point of view of design, construction, maintenance and operation of aircrafts.
- **Security**: illegal acts prevention.
- **Avoid** discrimination between states.

18 Annexes are the most important regulatory acts, consisting of recommended practices and mandatory standards.

4.2 National Agency for Civil Aviation (E.N.A.C)

(Official website: *http://www.enac-italia.it/* **)**

E.N.A.C was established in 1997 and, before the Linate accident, it coordinated the air traffic management between E.N.A.V. (National Flight Assistance Body, civil, website: http://www2.enav.it/) and B.S.A. (Air Space Brigade, military, site: http://www.aeronautica.difesa.it/BSA/) with functions of technical regulation, coordination and control in other air navigation sectors. After the Linate accident the reform of the Navigation Code of 9 May 2004 revolutionized the organization structure and made it become more powerful.

4.3 National Flight Security Agency (A.N.S.V.) (Official Website *http://www.ansv.it/*)

Main activities: **investigation** and **consultancy**

The National Flight Security Agency (A.N.S.V.) was established on February 25, 1999 with the same legislative decree also changed the Navigation Code, limited to the part relating to conduct of investigations on aviation accidents.

Task:

1. It carries out technical investigations relating to accidents and incidents occurring to civil aviation aircraft, issuing, if necessary, the appropriate safety recommendations.

2. It carries out studies and investigation activities in order to promote the improvement of flight safety.

It is an institution with a mainly investigative connotation, which does not have tasks of regulation, control and management of civil aviation system .

5 Technology

Most ATC still rely on Second World War technologies:

- Radar localization
- Two-way radio communication instead of Controller–pilot data link communications
- Paper flight progress strips.

Many technologies are used in air traffic control systems. Primary and secondary radar are used to enhance a controller's situation awareness within his assigned airspace,
all types of aircraft send back primary echoes of varying sizes to controllers' screens as radar energy is bounced off their skins, and transponder-equipped aircraft reply to secondary radar interrogations by giving an ID (Mode A transponder), an altitude (Mode C transponder) and/or a unique callsign (Mode S transponder). Certain types of weather may also register on the radar screen.

These inputs, added to data from other radars, are correlated to build the air situation. Some basic processing occurs on the radar tracks, such as calculating ground speed and magnetic headings.

Usually, a flight data processing system manages all the flight plan related data, incorporating the information of the track once the correlation between them (flight plan and track) is established. All this information is distributed to modern operational display systems, making it available to controllers.

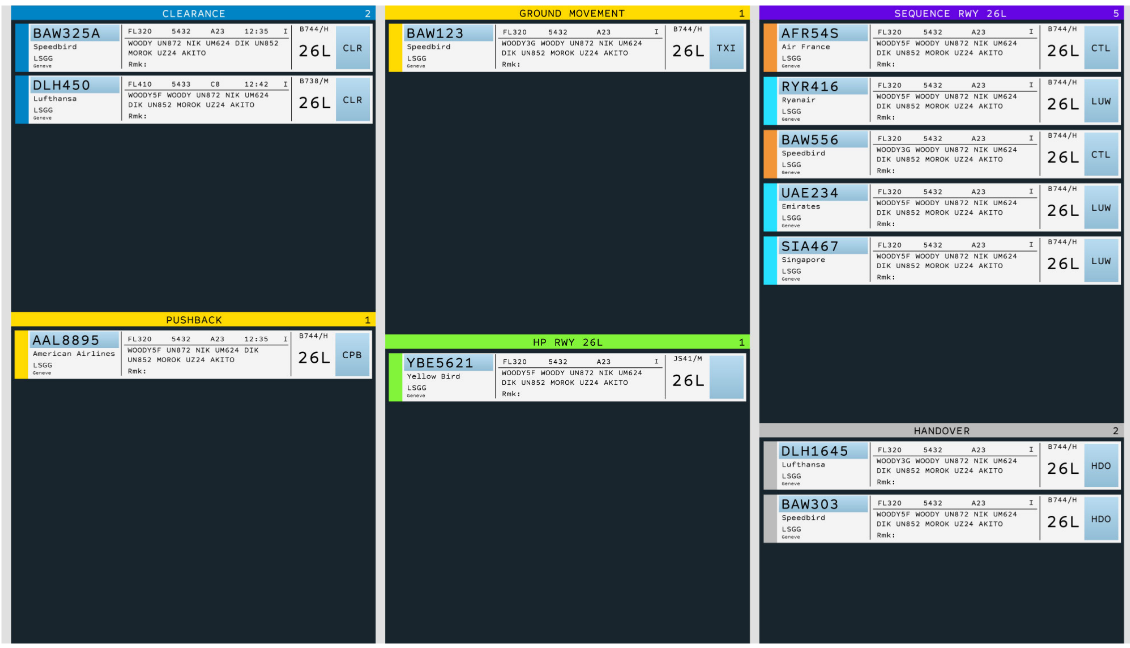
The FAA (Federal Aviation Administration, website: https://www.faa.gov/) has spent over $ 3 billion on software, but a fully automated system is still not possible. The most powerful technologies available to us today are:

- **Flight data processing systems**: this is the system (usually one per center) that processes all the informations related to the flight (the flight plan). It uses such processed informations to consult other flight plan related tools, and distribute them to all the stakeholders (air traffic controllers, collateral centers, airports, etc.).
- **Short-term conflict alert (STCA)** that checks possible conflicting trajectories in a time horizon of about 2 or 3 minutes and alerts the controller prior to the loss of separation. The algorithms used may also provide in some systems a possible vectoring solution, that is, the manner in which to turn, descend, increase/decrease speed, or climb the aircraft in order to avoid infringing the minimum safety distance or altitude clearance.

- **Minimum safe altitude warning (MSAW)**: a tool that alerts the controller if an aircraft is too near to the ground or will impact terrain based on its current altitude and heading.
- **System coordination (SYSCO)** to enable controller to negotiate the release of flights from one sector to another.
- **Area penetration warning (APW)** to inform a controller that a flight will penetrate a restricted area.
- **Arrival and departure manager** to help the sequence of the takeoff and landing of aircraft.
- **Converging runway display aid (CRDA)** enables approach controllers to run two final approaches that intersect and make sure that go arounds are minimized.
- **Mode S:** provides a data downlink of flight parameters via secondary surveillance radars allowing radar processing systems and therefore controllers to see various data on a flight, including unique ID (24-bits encoded), indicated airspeed and flight director selected level.
- **CPDLC:** controller-pilot data link communications, allows digital messages to be sent between controllers and pilots, avoiding the need to use radiotelephony.

- **ADS-B:** automatic dependent surveillance broadcast, provides a data downlink of various flight parameters to air traffic control systems via the transponder. The most important is the aircraft's latitude, longitude and level: such data can be utilized to create a radar-like display of aircraft for controllers.

- **The electronic flight strip system (e-strip)**:



A system of electronic flight strips replacing the old paper strips is being used by several service providers. E-strips allows controllers to manage electronic flight data online without paper strips, reducing the need for manual functions, creating new tools and reducing the ATCO's workload.

- **Screen content recording:** Hardware or software based recording function which is part of most modern automation system and that captures the screen content shown to the ATCO. Such recordings are used for a later replay together with audio recording for investigations and post event analysis.

- **air traffic management (ATM) systems** are communications, navigation, and surveillance systems, employing digital technologies, including satellite systems together with various levels of automation, applied in support of a seamless global air traffic management system.

To have another system upgrading we should wait 2011, and the birth of NexTower idea.

6 Nextower

6.1 What is Nextower and his purpose

The tower ATM system upgrading started in 2011 when the groundwork of NexTower has been created.
Putting the focus on the final user the project purpose was to modernize Towers using a “user centered” method, for this reasons one of the most important things, and at the same time the most difficult one, is upgrading the Control Working Position (CWP).

6.2 Control Working Position

The CWP is the air traffic controller’s “work environment” , where he makes important decisions and tool that determinate mission success or failure. CWP’s construction principles are ergonomics and flexibility, using an intuitive human-machine interface.
That technology is able to reduce learning time during training period, increase long term and short term memory, trying to show on screen only informations selected and useful.
The CWP’s brain are the Electronic Flight Progress Strips (EFPS), where all the informations are elaborated and sorted.
But NexTower is not only EFPS. There is much more. It wants to create an innovative tower system design, using automation and the

power of technology to help Air Traffic Controller (CTA) in order to produce a more efficient Air Traffic Service. NexTower is able to reduce manual input at minimum, giving a panoramic situation.

New CWP and EFPS together give at the tower operative team improvement about situational awareness and safety, helping them also in the Decision Making Process.

6.3 Malpensa “Case”

Malpensa airport is the first Italian Airport to adopt this technology.

It is the largest international airport in the Milan metropolitan area. The airport is located 49 kilometers northwest of central Milan, next to the Ticino river. The airport has two terminals (Terminal 1 and Terminal 2) and two runways as shown in Figure 1.

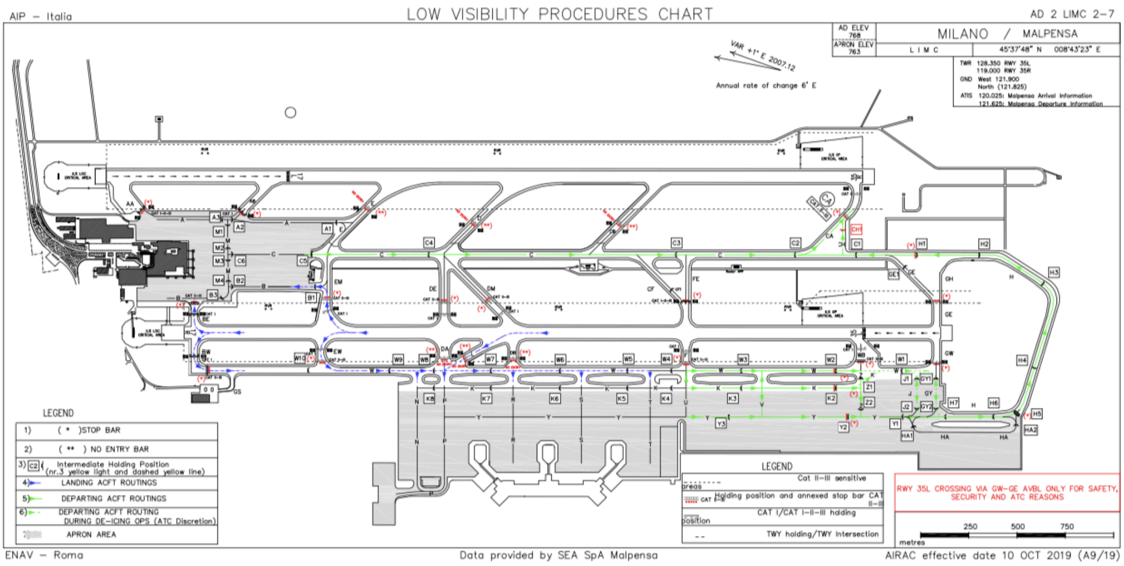


Figure 1
Malpensa airport Chart
From Italian AIP

The new operative room have 7 Control Working Position able to work in all the configurations, changing informations to give to the CTA based on his operative role.

The VCR layout presented in figure 2 & figure 3 is referred to a situation with all CWPs opened and runway in use 35 L/R.

Thanks to technology of working positions in case of emergency, positions failure or other runway in use, supervisor can assume different positions configurations.

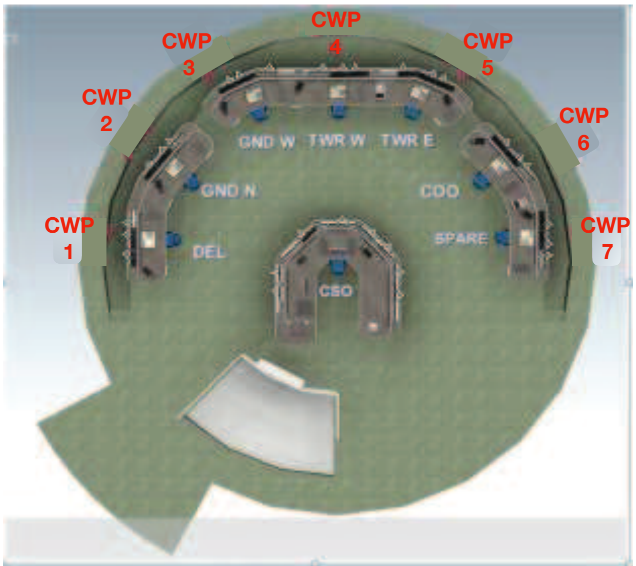


Figure 2
Malpensa Layout

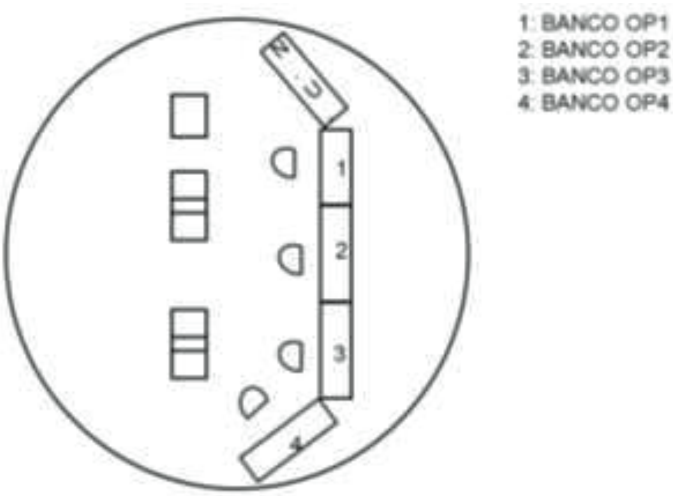


Figure 3
Malpensa Layout

CWP CSO	
SUITE NAV CANADA	Designed for supervisor role
OPERATIVE APPLICATIONS	AOIS, A-CDM, FDP, TTM Legacy, E-AWOS, ATIS, AVL, NAVAIDS
SUITE NAV CANADA FALLBACK	Surveillance from this suite is shown on high-monitor with extend default label
VCS M600 (CSO Operator)	
TAM TAM	
Master NAVAIDS STATUS MONITORING	Independent system not integrated on suite NavCanada
Master TELECOMANDO AVL (ALCMS) & Alarms Control	Independent system not integrated on suite NavCanada Presentation of this tele control is put on the high-monitor
BADGE READER	
Fax & Printer	
PC multiutenza rete SIG	
PC InfoScreen	This informations are reported on the high-monitor in extended desktop modality

CWP 1 (Delivery)	
SUITE NAV CANADA	
OPERATIVE APPLICATIONS	AOIS, A-CDM, FDP, TTM Legacy, E-AWOS, ATIS, AVL, NAVAIDS
VCS M600 (Operator 1)	
Emergency VCS	
Workstation FDP legacy with Departure strips print and display	Independent system not integrated on suite NavCanada
BADGE READER	

CWP 2 (GND Nord)	
SUITE NAV CANADA	
OPERATIVE APPLICATIONS	AOIS, A-CDM, FDP, TTM Legacy, E-AWOS, ATIS, AVL, NAVAIDS
VCS M600 (Operator 2)	
Emergency VCS	
Apron Nord camera control	
BADGE READER	

CWP 3 (GND West)	
SUITE NAV CANADA	
OPERATIVE APPLICATIONS	AOIS, A-CDM, FDP, TTM Legacy, E-AWOS, ATIS, AVL, NAVAIDS
VCS M600 (Operator 3)	
Emergency VCS	
Apron Nord camera control	This informations are reported on the high-monitor in extended desktop modality
BADGE READER	

CWP 4 (TWR West - 35L)	
SUITE NAV CANADA	
OPERATIVE APPLICATIONS	AOIS, A-CDM, FDP, TTM Legacy, E-AWOS, ATIS, AVL, NAVAIDS
VCS M600 (Operator 4)	
Emergency VCS	
BADGE READER	

Between CWP 3 e 4	
INTERCOM WITH MILANO ACC	

CWP 5 (TWR Est - 35R)	
SUITE NAV CANADA	
OPERATIVE APPLICATIONS	AOIS, A-CDM, FDP, TTM Legacy, E-AWOS, ATIS, AVL, NAVAIDS
VCS M600 (Operator 5)	
Emergency VCS	
BADGE READER	

Between CWP 4 e 5	
INTERCOM WITH MILANO ACC	
Airport alert buttons	
Alarms Speaker AVL	

CWP 6 (COO)	
SUITE NAV CANADA	
OPERATIVE APPLICATIONS	AOIS, A-CDM, FDP, TTM Legacy, E-AWOS, ATIS, AVL, NAVAIDS
EFPS strip printer	Connected to Suite NavCanada
VCS M600 (Operator 6)	
Emergency VCS	
Airport alert buttons	
Alarms Speaker AVL	
Workstation FDP legacy with Arrival strips print and display	Independent system not integrated on suite NavCanada
BADGE READER	

CWP 7 (Spare)	
SUITE NAV CANADA	
OPERATIVE APPLICATIONS	AOIS, A-CDM, FDP, TTM Legacy, E-AWOS, ATIS, AVL, NAVAIDS
VCS M600 (Operator 6)	
Emergency VCS	
BADGE READER	

7 Safety & Security innovations

In aviation's history we had a safety or security innovation only after a tragic episode, that sown the previous method critical issues.

For example the exponential increase after the September 11,2001.

Reporting the most important modify in air traffic control management and main incident/accident

The main incedente that threatened aviation's safety in last years are many "Runway incursion" (not authorized aircraft that occupy runway) and accidents. About that we will talk only about Tenerife March 27, 1977 (583 victims) and Linate October 8, 2001 (118 victims).

1. After a lot of "Runway incursion" we understood that it was caused by an inaccurate use of phraseology: Actually we consider that "Taxy to holding position" is the best. Previously we used : "Taxy to hold in position" (taxy until maintain position), this difference deceiving pilot (in particular European pilots in USA) that

usually think they was cleared to align with runway and commit "Runway incursion"

2. TENERIFE: During communications between Tower and pilots has been used the word "clear" and "take off" not in the right way. Today to avoid misunderstanding we use that one only to authorize an aircraft to take off, not in taxiing phases.

3. TENERIFE/LINATE: In both situations had not been applied "Low Visibility" procedures. Actually, after Linate's events, in all the airports this procedure are in use if visibility is under the bound and consist in ground movement limitation (one aircraft at time can move in the maneuvering area). Furthermore, in the procedure there are continuous reports of position by the pilots to allow the controller to always understand where the aircraft is, even if he does not see it.

4. LINATE: After the accident, inspections were carried out at all airports to verify the efficiency of vertical signs. It was installed where it was missing, or on all airports.

5. LINATE:The Ground Radar was missing because it had been dismantled in 1999 to be assigned to Malpensa airport. This type of radar continues to be lacking in the majority of aerodromes, however the Controllers have started to carry out a training course on the use of this instrument since 2003

7 .REPORTING CULTURE: Since 1991, the Italian Air Force has developed a system that does not contemplate punitive consequences, based on the reporting of dangerous events ("no blame" system). This system has encouraged the pilots' confidence. In the early years, the number of reports was quite low, including increased progressively, reaching 1773 reports in 2004 and over 2000 in 2005. This is due to

the intense education, involvement and collaboration activities carried out by the Inspectorate for Flight Safety after the Linate accident.

8. ACCIDENT of 22.09.2004 - MALPENSA

We can evaluate how the implementation of NexTower at Milan Malpensa could have avoided the accident of 22 September 2004

8.1 GENERALITY

On 22 September 2004, at 5.22 UTC, the flight SAS688 was authorized to take off from runway 35L at Milan Malpensa airport, with the same runway still occupied by flight LDI9330, in the taxiing phase.

8.2 EVENT

At the time of the handover between the controllers, a runway 35L crossing series were taking place by three aircraft.

- **First one**

  Flight LDI 9330, in contact with GND on frequency 121.900 MHz, had been cleared to cross runway 35L without contacting TWR on frequency 128.350 MHz.

- **Second one**

  Flight SAS688, in contact with TWR on frequency128.350 MHz was cleared to take off from runway 35L.

- **Third one**

  TWR controller did not see flight LDI9330 entering runway 35L.

Weather conditions did not represent a critical element for the event and allowed optimal visibility along entire runway 35L.

Flight SAS688's pilot identified LDI9330's runway incursion and stopped the take-off run at about 20 knots.

Immediate interruption of take-off maneuver allowed flight SAS688 to still have enough runway to take off from the same stopping position.

8.3 CAUSE

Identified cause of the event was flight SAS688’s take off clearance before completion of crossing runway 35L by flight LDI9330.

Causal factors:

- Missed application of standard in use that consist in contact tower before crossing runway
- Missed efficient coordination between GND and TWR

8.4 WHAT COULD HAPPEN THANKS TO NEXTOWER

To evaluate how NexTower could help to avoid the accident, we must first do a more detailed analysis of what happened.

One of the most concrete and practical causes of the accident is the fact that airport aviation needs "runway crossing" operations. The runway, when used by an active operation such as crossing or take-off, requires a series of operations from the controller which at the time could also be delegated to another one, leaving him the possibility of grant clearance to cross the runway.

This result in a potential risk's procedural aspect, cause the crossing authorization communications were made on 2 different frequencies (frequency separation in slang).

In fact, the 2 traffics were neither seen nor heard (communications with the tower took place on different frequencies) and, while it is normal that happens in the sky on the ground it is much more dangerous.

That day a traffic was lined up with the runway and authorized for take-off, when the controller at the same time granted authorization to cross; Pilot signaled presence of another crossing and controller replied: "Oh yes, sorry".

How could Nextower have helped in this situation?

In NexTower system, placing the electronic strip in a specific bay, had an ACTIVE FUNCTION associated.

For example, if I place a departure in the runway bay and give the TAKE OFF command, this action causes a series of repercussions on the whole system. First of all, in all CWP's, runway changes color becoming ORANGE, meaning that runway is occupied by an operation, a simple but effective alert that informs all controllers about critical operation in progress in a particular portion of maneuvering area.

Same operation, if a delegated crossing were still possible today as in the past, could be less critical by setting crossing as an active function that colors the runway, consequently others controllers before authorizing take-off could realize that runway was at that time subject to another critical event which in our specific case was the crossing.

Nextower provides informations' integration and digitization within systems that were not previously available. This is possible through a fundamental technology: systems able to communicate with each other. In fact, informations puts in the electronic strip transmit the same visually in the situational presentation (radar screen).

In the past, signaling runway occupation was done alike: a strip marked the event and placed in the strip container.
So event was reported, but it remained there in the strip container!

Instead thanks to this technological innovation, if I simply move the electronic strip in a correctly proceduralized mechanism, this does not keep the information only in the strip container, but exports it to others integrated systems within Nextower (mainly the radar screen because the controller uses it as an aid)

But remember that the controller mainly looks out, so an observation that a detail-conscious person might make is:

Controller before authorizing take-off could not look out ?!

Yes that's right, he will ALSO have looked out, but in reality the delegation crossing situation and coordination could have **DISTRACTED** him.

One of the greatest benefits and purposes of an integrated system such as NexTower is to incorporate in a single system the whole range of information and make it available, to limit error possibility.

So NexTower is technology to support operations by creating situations of information integration with respect to everything that was not previously available at Malpensa since 2019.

8.5 SUMMING UP

We can say that in the 2004 event he would certainly have HELPED the controller but, also including the human factor, we can not say that he would certainly have avoided the accident. Surely this powerful tool would increase the SITUATIONAL AWARENESS of the controller, and would help him make the best possible decision.

In fact, technological updating can do nothing without the skills of a human who implements into practice informations received and through the skills developed during training and practice years does not direct traffic.

9. COST - BENEFIT ANALYSIS

Another interesting observation is the cost-benefit analysis, that is the evaluation of the possibility of implementing a technology in an airport, starting from the principle that technologies have a cost, with the possibility of increasing certain factors:

-Airport traffic conditions:

> *"Does it make sense to invest in Malpensa?"*
>
> Malpensa is Italy's second largest airport, so it probably makes sense
>
> *“Does it make sense to invest in an airport that potentially carries out critical operations such as crossings?”*
>
> Yes, Malpensa has two parallel runways so an investment in an operation, considered one of the most critical, deserves to be supported by technology. Especially for runway crossing issues (main apron is on west side and some aircraft need to cross a runway 35L when they land on 35R).

-Airport weather conditions:

"Does it make sense to invest in a fog Weather Radar in Bari?"

Probably not, because possibility of the fog event occurring in Bari is low.

"Does it make sense to invest in windshear analysis in Palermo?"

Probably yes, because it is an airport subject to this phenomenon

10.PROCEDURES

To evaluate what happened, one aspect that certainly cannot be overlooked are procedures.

It is always important to remember that it is not only type of instrument you have that guarantee safety.

Technology allows you information’s quality and awareness of what you can do as operations, but an important aspect is always linked to procedures.

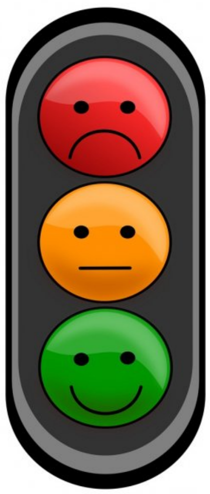
In the past there was also a procedural criticality: many controllers did crossing delegation on another frequency only because nowhere was written that it was not allowed to do, but probably this could easily favor that someone could lose informations’ “pieces”, causing problems.

“With years this procedural aspect has also been corrected and disappeared, but technology and procedures together guarantee operations’ quality and safety.

11. A-SMGCS INTEGRATION

Another aspect of NexTower to estimate, not just trying to see how this tool *could have helped* trying to import a theoretical concept into a practical experience, is that NexTower's informations integration A-SMGCS (Advanced Surface Movement Guidance & Control System) can provide 2 types of alarm.

To explain better, let's use the traffic light as an example



YELLOW is: Beware, if you don't do something soon the situation could became critical.

RED is : You MUST take action because something wrong is happening.

This is what NexTower helps you to do, there are certain alarms that require immediate intervention and others that require controller's attention to inform him to increase situational awareness.

A NexTower’s practical example is that if you authorize take-off and crossing together, a POP-UP appears and tells you:

“WARNING! You did TAKE OFF Vs CROSS and the flights involved are….”

And ask you “Confirm? ”

making sure you're realizing what's going on.

There are disseminations of information that are not only provided in colors, but also through warnings and pop-ups that appear to you and tell you "are you sure what you are doing is correct?"

So, controller receives information from system itself that suggests more or less timely actions depending on the severity of event that is about to occur.

Regarding that we can talk of CATC (Conflicting ATC Clearances) (RED light) and ALERT (YELLOW light)

11.1 GENERAL

-The Conflicting ATC Clearances (CATC) tool is a **safety net.**

-CATC is covering just the runway environment

-CATC tool provides controllers with alerts in case of input into the EFPS of clearances that are virtually in conflict or that could lead to an unsafe situation.

-The early detection of Conflicting ATC Clearances (predictive tool whilst RIMCAS is a short term tool) aims to provide a prediction of situations that, if not corrected, would end up in hazardous situations.

-The conflict conditions, the clearance input required to trigger the alert and the main HMI issues will be addresses.

> It is important to note that the term 'Conflicting' in the title refers to the fact that certain clearances input on the EFS at the same time by an ATCO do not comply with the local ATC rules/procedures, it does not mean that the aircraft/vehicles have ended up in conflict with each other.

11.2 DEFINITIONS

Conflict [ICAO-A-SMGCS] definition

A situation when there is a possibility of a collision between aircraft and/or vehicles.

Alert [ICAO-A-SMGCS] definition

An indication of an existing or pending situation during aerodrome operations, or an indication of abnormal A-SMGCS operation, that requires attention/action.

11.3 MAIN GENERAL REQUIREMENTS

1) ATCO shall receive CATC alerts on the concern TWR ROLE EFPS HMI.
2) It shall be possible to activate/deactivate the CATC tool via a button on the EFPS main toolbar or just some triggering events through an administrator menu .

3) ATCO shall be able to quickly and univocally identify the mobiles (aircraft or vehicles) involved in the CATC alerts.

4) The CATC tool shall be able to manage multiple alerts.

5) ATCO shall have the means to acknowledge all the alerts via the “Alert Window”.

6) ATCO shall only receive alerts for which the alert triggering conditions are still valid and the terminating conditions are not satisfied yet (refer mainly to surveillance contribution).

7) CATC tool shall be locally customizable in accordance to the Airport constraints.
8) Color Coding shall be defined and used for the CATC alerts
9) CATC alarms and acknowledge must arrive on real time (at the time the input is made on strip)

11.4 HMI ITEMS-ALERT WINDOW

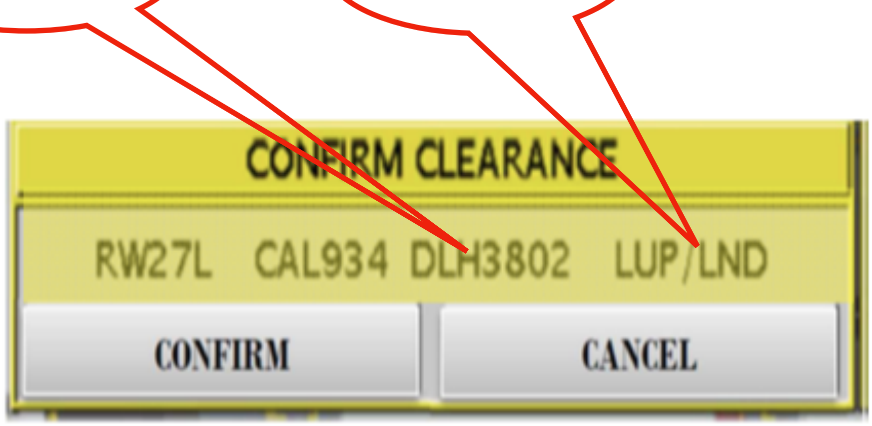
The HMI shall provide ATCO with alert messages for the conflicting clearances events detected by CATC

The alert window is yellow with grey buttons as the picture below

The alert window **shall appear as soon as the conflicting command is provided on the strip and just below** the concerned runway panel (in MXP the taxiout panel) in the same area where ATCO eyes are focusing , but NO SOUND is required;

The “Alert Window” shall clearly contain:

the **involved traffic** and the **type of conflict**



Through the "***Alert Window***" is possible to acknowledge the alert message requesting the ATCO to confirm or cancel the last clearance:

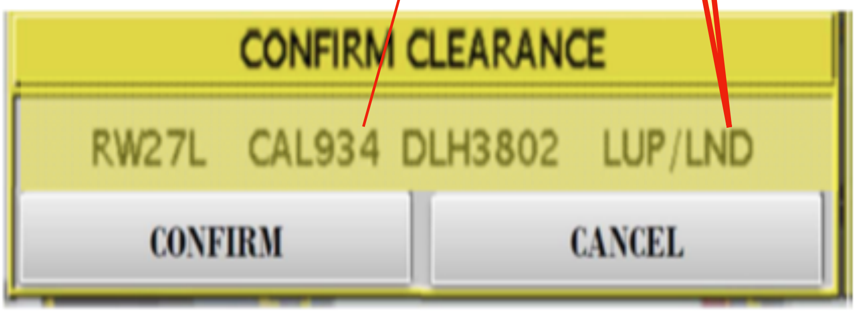
>**CANCEL** : the last clearance is deleted, the "conflicting" strip stays in its original position and the alert message disappears at once

>**CONFIRM**: the alert message disappears at once and the concerned strip moves according to the last clearance.

NOTE

LINE UP vs LAND (LUP-LND)

The alert window shall be consistent with the time sending of the clearance, always showing first, the first clearance provided, and deleting through the CANCEL button the second clearance provided.



12. LIST OF MXP CATC TRIGGERING EVENTS

MXP = Malpensa

In order to be able to know in advance all implemented triggering events the following pages show the events selected for Malpensa airport, no other events shall be added without preventive coordination with ENAV.

The adaptation created for CATC showed some nuisance alarms or situation not meaningful operationally or redundant : those events are reported in the next pages and they shall be removed for next SAT.

NB. Crossing a/c, Engaged and closed runways must be considered, in CATC, as distinct events with different operational impact; to merge these events into a single one to simplify the system it’s causing nuisance.

12.1 A/M CROSS Events

Crossing Events (RWY 35L/17R) conflict against the following:

- LAND: 35L or 17R;
- TAKEOFF: 35L or 17R;
- TOUCH & GO: 35L or 17R;
- LOW PASS: 35L or 17R;
- CLOSED same or opposite RWY

Events deleted from adaptation:

- **Cross vs cross**
- **Cross vs ENTER: Ground Vehicle or Engaged RWY 35L or 17R and viceversa**
- **Cross vs Line up both rwy and viceversa**

12.2 LINE UP Events

Line up Events with a blank RHP conflict against the following:

- LAND: same and opposite runway;
- TAKEOFF: same and opposite runway;
- TOUCH & GO: same and opposite runway;
- LOW PASS: same and opposite runway
- CLOSED RWY : same and opposite
- LINEUP: opposite and same runway

NB. TAKE-OFF VS LINE UP EVENT SHALL BE TRIGGERED just whist the blue arrow is on the strip (which means a/c cleared for take off but not airborne yet), once the time is stamped we suppose a/c airborne so no conflict.

Events deleted from adaptation:

- **LUP vs Ground Vehicle entering the runway or Engaged same or opposite runway. (LUP vs. Engaged & LUP vs. Enter)**
- **LUP vs Cross**

Line up Events with assigned RHP conflict against the following:

- LAND: same and opposite runway;
- TAKEOFF: opposite runway;
- TAKEOFF: same runway if LUP is in front of the a/c taking off (system is considering the RHP reported on strips);
- TOUCH & GO: same and opposite runway;
- LOW PASS: same and opposite runway
- CLOSED RWY : same and opposite
- LINEUP: opposite runway,
- LINEUP: same runway with 'blank' RHP

NB. TAKE-OFF VS LINE UP EVENT SHALL BE TRIGGERED just whist the blue arrow is on the strip (which means a/c cleared for take off but not airborne yet), once the time is stamped we suppose a/c airborne so no conflict.

Events deleted from adaptation:

- **ENTER: Ground Vehicle or Engaged same or opposite rwy.**
- **Line up same rwy in sequence from same/opposite intersection**
- **LUP vs Cross**

12.3 TAKE OFF Events

Take off events with assigned RHP conflict against the following:

- LAND: same and opposite runway;
- LINEUP: opposite runway;
- LINEUP: same runway if from a RHP in front of the one used from the taking off a/c ;

NB. Take Off will not conflict with a LUP from same or opposite RHP if same departure runway;

- TAKEOFF: same and opposite runway;
- TOUCH & GO: same and opposite runway;
- LOW PASS: same and opposite runway;
- CROSS: only applies to event for RWY 35L/17R;
- ENTER: Ground Vehicle or Engaged same or opposite RWY.
- CLOSED same or opposite RWY

Take off events with a blank RHP conflict against the following:

- LAND: same and opposite runway;
- LINEUP: same and opposite runway;
- TAKEOFF: same and opposite runway;
- TOUCH & GO: same and opposite runway;
- LOW PASS: same and opposite runway;
- CROSS: only applies to event for RWY 35L/17R;
- ENTER: Ground Vehicle or Engaged same or opposite RWY.
- CLOSED same or opposite RWY

NB. For CATC purposes the TAKE-OFF event ends once the time is stamped and the blue arrow disappears

12.4 LAND, LOW PASS, TOUCH AND GO Events

Landing, Low Pass and Touch & Go Event(s) conflict against the following:

- LAND: same and opposite runway;
- LINEUP: same and opposite runway;
- TAKEOFF: same and opposite runway;
- TOUCH & GO: same and opposite runway;
- LOW PASS: same and opposite runway;
- CROSS: only applies to event for RWY 35L/17R;
- ENTER: Ground Vehicle /Engaged/closed same or opposite RWY.

NB. for a TOUCH & GO and LOW PASS all events shall be triggered until the concern strip is placed in the runway panel. FOR LANDING the events are triggered until runway is vacated (means selection of VAC as next action)

12.5 VEHICLE ENTER /ENGAGED RWY Events

Vehicle enter /engaged Rwy Event(s) conflict against the following:

- LAND: same and opposite runway;
- TAKEOFF: same and opposite runway;
- TOUCH & GO: same and opposite runway;
- LOW PASS: same and opposite runway;

Events deleted from adaptation:

- **Vehicle enter vs CROSS and vice versa**
- **Vehicle enter vs ENGAGED/CLOSED and vice versa**
- **Vehicle enter vs vehicle enter**

13. OTHER INTERESTING NEXTOWER SKILLS

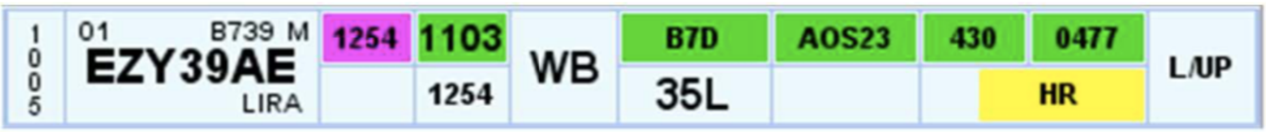
Disabling take-off order with Hold for Release

Take off command disabled with Hold for Release option

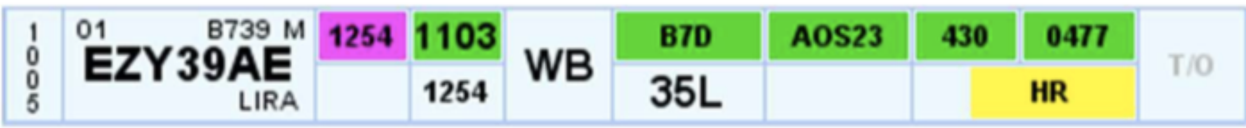
When Hold for Release is selected the Take-Off button is disabled.

Step 1: The ATCO (generally the COO) issues HR from Clearance Options on the window window, strip appears

with yellow HR in the departure instructions



Step 2: The ATCO moves strip into the RWY panel with T/O now ‘grey’ because the Hold and Release is still active (still yellow on the strip)



Step 3: When the ATCO selects the yellow ‘HR’ on the strip, hold and release (HR) is removed, T/O (takeoff) is again active and returns to black default colour - from this point, standard data-flow.

Or When Hold for Release is selected the Take-Off button is disabled.

Step 3: ATCO attempts to issue takeoff clearance on ‘greyed’ T/O next action button, ATCO is provided the following:

If the ATCO selects the yellow ‘HR’ on the strip, hold and release (HR) is removed, T/O (takeoff) is now again active and returns to black default colour. From this point, standard data-flow.

14. IMPLEMENTATION

NexTower has been present in Malpensa since April 2019 and, leaving out some initial critical issues, the system is now working very well.

As all implementations in high reliability organizations, where zero error must be the goal, before being able to install NexTower in Malpensa airport, of course, a trial period had to pass, in particular the implementation period regarding NexTower outside Malpensa lasted 2-3 years, and is divided into the following phases:

First Phase: Creation of a prototype

(at the ENAV national test room)

Certain general specifications were developed not at Malpensa, but in Rome with a specific Team which was also composed of Malpensa controllers to create features to refine the system.

Second Phase: Implementation in a physical trial room

In this case at Malpensa, a simulation and disaster recovery room located just below the control room, where the air traffic controllers interfaced with the real traffic, simulating it.

Until the month before the final implementation at the ENAV national test room in Rome Ciampino, simulations were carried out with simulators with exercises tailored to simulate a sustained traffic load.

Third Phase: Operational implementation

It also includes an operational training phase, which ran from October 2018 to March 2019. This is to ensure that the controllers could train and familiarize themselves with the new tool.

The platform is going to be installed at Linate and is also expected to be installed at Fiumicino.

Integrating a new system into a simulated training suite was not easy but a good job was done, with enough information to train the controllers on the main novelty, that is use of electronic strip versus paper strip, together with an high information quality available.

Regarding this point, a difference compared to older method to be highlighted is standardized position of informations, so where you can find them. In fact, the board is standardized and, while before each controller had a minimum of individual "personalization" that differed from what had been taught at ENAV academy, inserting informations into a standardized board, even at handover moment (passage of command from one controller to another), are easily identifiable and reachable in known and shared points of the system.

15. CONCLUSION - CLICK AS YOU TALK

In conclusion NexTower is based on *CLICK AS YOU TALK* concept, which means that when you are giving traffic instruction you click in the system giving an input that translates the instruction into it.

If the system does not receive traffic information, it cannot help controllers to avoid problems.

The great strength of NexTower is the possibility to "digitize" the process with advantages:

1) Put in communication two systems that previously did not communicate: paper strip and the Radar.

2) Information shared within the entire operational line, thus providing an overall AWARENESS, so when operational line is complex (we consider a complex operational line with more than 2 controllers, because in more than two communicating and having everything under control starts to become difficult and Malpensa's configuration, as we have seen, reaches 5 people plus head nurse) everyone has all the informations at hand and has an high SITUATIONAL AWARENESS’ level.

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Questa laurea conseguita nei tempi stabiliti, nonostante le difficoltà iniziali e un anno di lavoro in aeroporto, è la prova di come ogni persona, con amici e famiglia che la sostengono, possa raggiungere qualsiasi obiettivo.

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