Advanced M&S applied to Analysis Techniques for Supporting Decision Makers in Multi-Job Management in an Aeronautical Industry

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Goals of the Research

The main goal of the Research is to reduce the Assembling Line Lead Time. In order to reach this goal is requested to:

- Identify and Analyze Criticalities
- Reorganize all the Phases of the Production Process
- Evaluate the Impact of all the Stochastic Phenomena

First Hypothesis of Assembling Line Lead Time Reduction

	operai/giorni	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		Squadra A	Squadra B
1°Turno	1	6	6	6	6	6	6	11	11	TEST WEE				17	17	23	23	23	23	23	23		Bidone	Garbati
	2	8	8	8	10	10	10	11	11					17	17	23	23	23	23	23	23		D'Agostino	Salvador
	3	9	9	9	9	9	9	9	9		9	9	9	9	18	18	18	18	18	18		Zone	Cecchini
2°Turno	4	12	12	13	13	13	13				24	24	24	24	23	23	23	23	23	23		Canepa	Fois
	5	12	12	13	13	13	13				24	24	24	24	23	23	23	23	23	23		Astengo	Macciò
	6	15	15	15	10	10	10	14	14		14	14	14	14	34	34	34	34	34	34		Gaggero	Palladino

										1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Predisposizione Modifiche	6	50 ore 1pers								1	1	1	1	1	1			TEST WEE											
Installazioni Portelli	8	25 ore 1 pers								1	1	1																	
Installazione Canard	9	110 ore 1pers								1	1	1	1	1	1	1	1			1	1	1	1						
Assy portelli principali e posteriori	10	50 ore 2 pers											2	2	2														
Installazione portello bagagliaio	11	35 ore 2pers														2	2												
Installazione particolari fuori scalo	12	25 ore 2 pers								2	2																		
Predisposizione bulbo deriva	13	60 ore 2 pers										2	2	2	2														
Predisposizione poppino	14	50 ore 1 pers														1	1			1	1	1	1						
Installazione antenne	15	24 ore 1 pers								1	1	1																	
installazione pinne	17	35 ore 2 pers																				2	2	1	1	1	1	1	1
Raccordo ala fusoliera	18	50 ore 1 pers																											
installazione Flap	23	200 ore 4pers																						4	4	4	4	4	4
Installazione alettoni	24	60 ore 2 pers																		2	2	2	2						
Verniciatura basico	34	58 ore 1pers																						1	1	1	1	1	1
		persone per giorno								6	6	6	6	6	6	4	4	0	0	4	4	6	6	6	6	6	6	6	6

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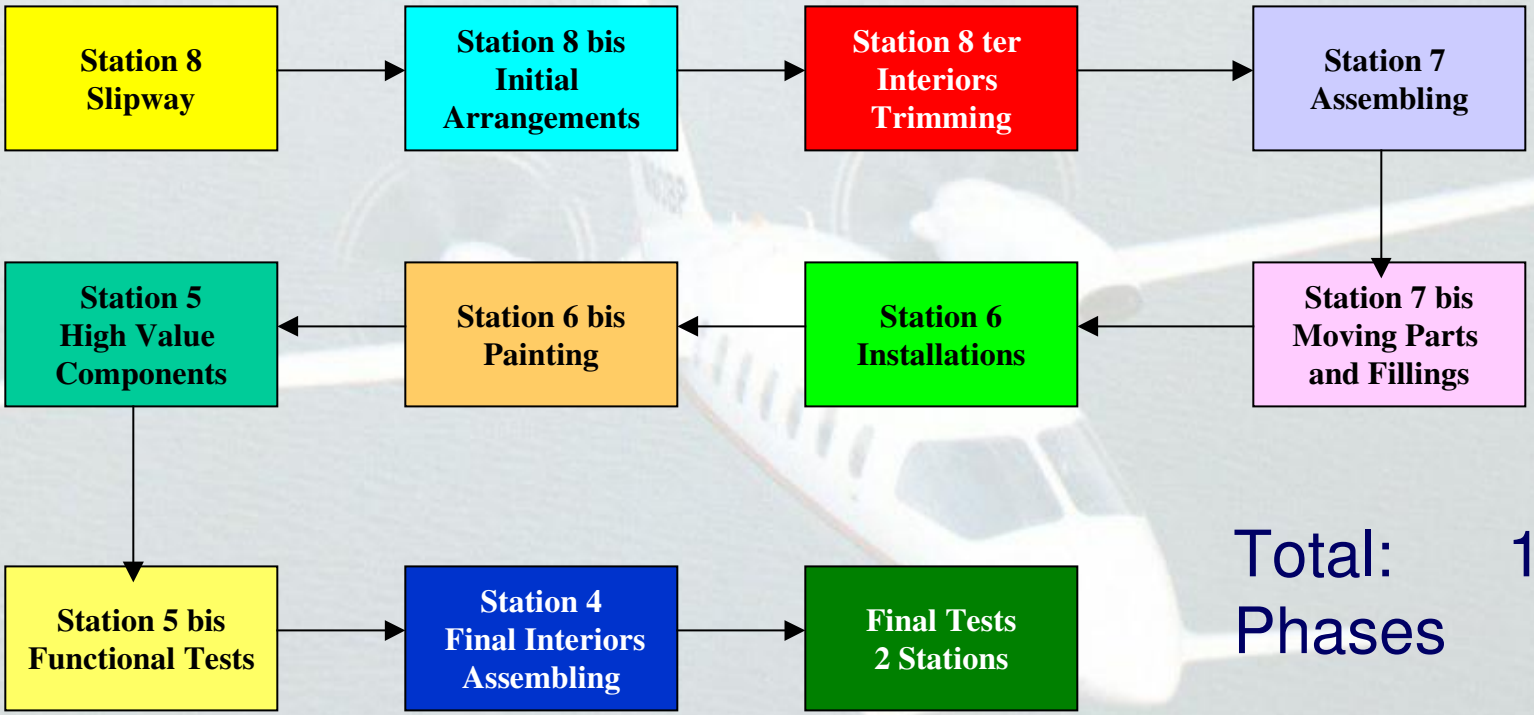
•*Data have been Modified due to their Confidential Nature*

Methodology

- Build Simulators and Models devoted to analyze Risks and Criticalities
- Development and Analysis of the Assembling Line Systems in order to:
  - Reduce the Aircraft Mean Lead Time from 6 to 4 Months
  - Reduce WIP
  - Decrease the Number of Aicrafts simoultaneously present in the Assembling Line
  - Save a significant amount of Money in terms of Banking Interests
  - Distribute better Resources on Planes
  - Have a Positive impact on the Company Cash Flow

The Present Productive Processes



Total: 12 Phases

LT = 24 Weeks

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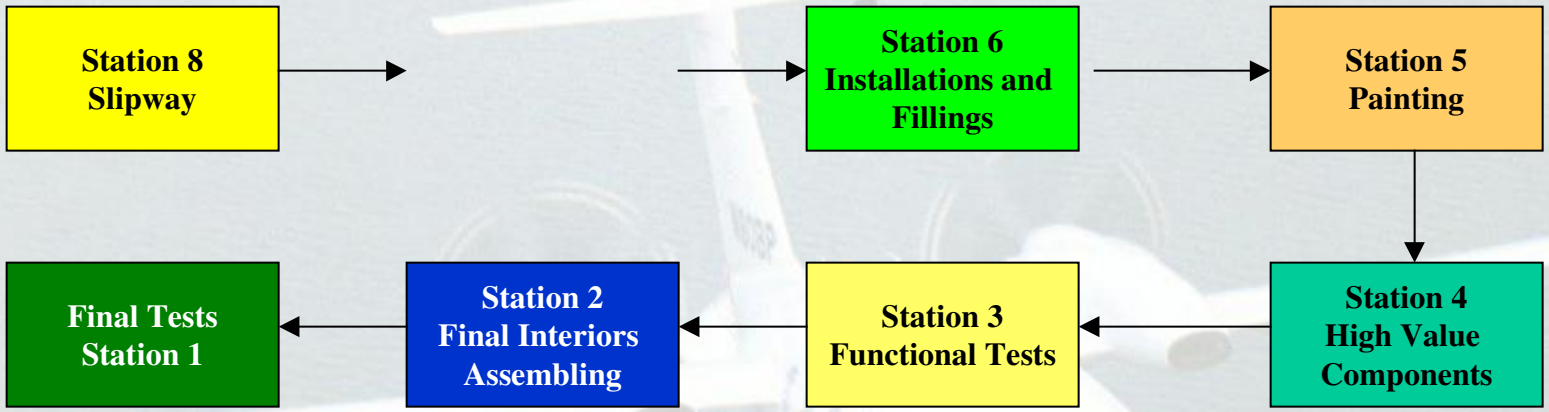
New Assembling Line



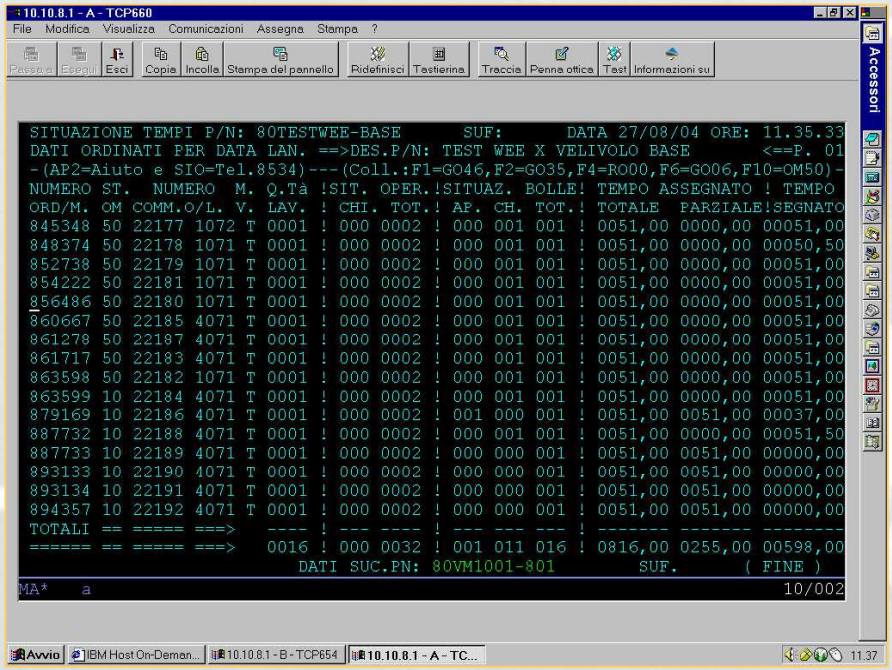
Total: 8 Phases

LT = 16 / 18 Weeks

Departments to be Reengineered

- Assemblers' Dept.: Code 742
  - Carpenters
  - Fillers
  - Commanders
  - Planters
  - HVAC
  - Assemblers
- Electricians' Dept.: Code 744
- Interiors' Dept.: Code 745
- *Painters' Dept.: Code 743*

Data Collection

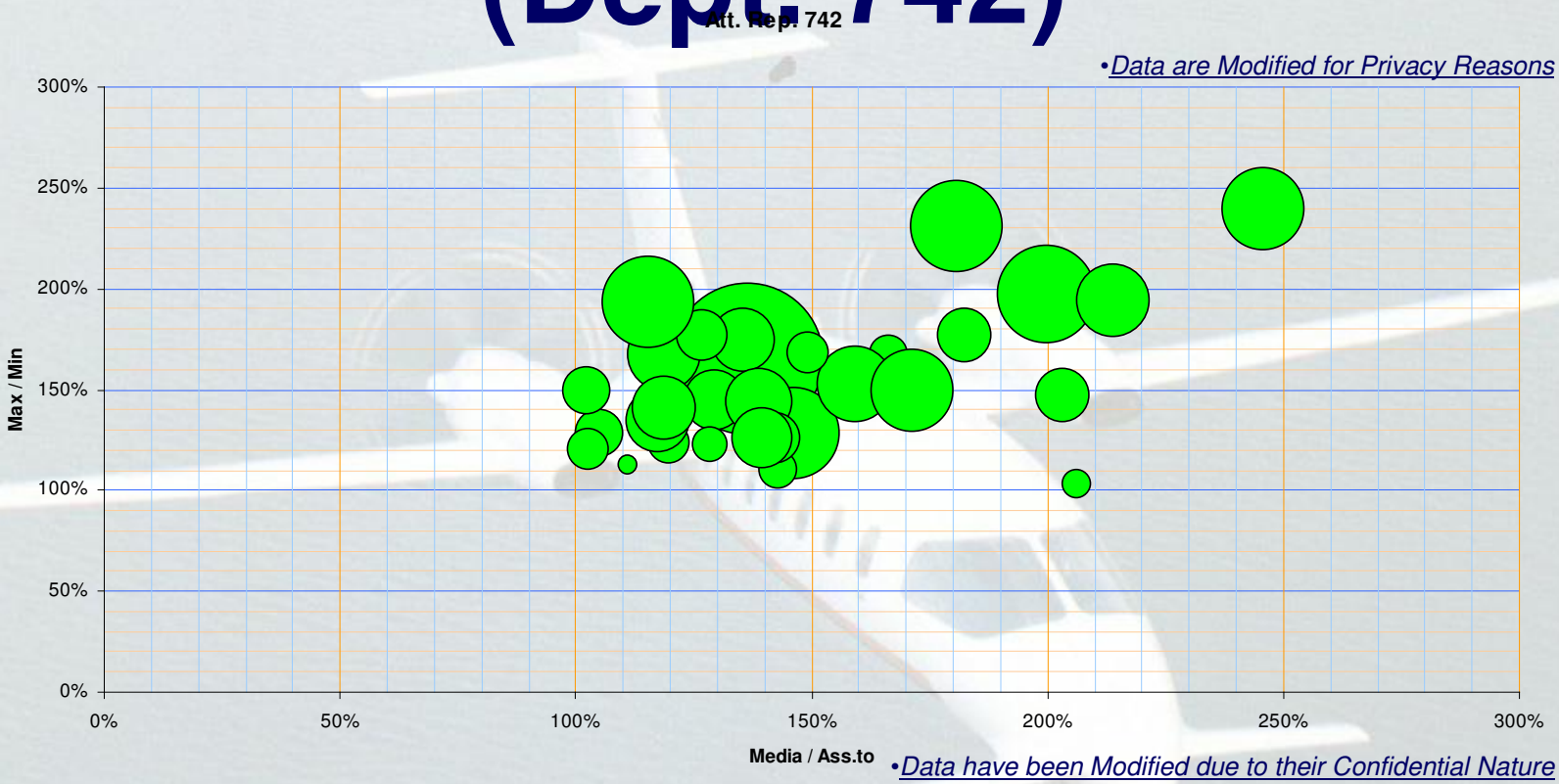


Data were acquired by the Authors using the LAN-Based Company Informative System (CX)

The Main Functions are:

- Inventory Status
- Bills Control
- Job Progress Control
- Worked Hours Control

Performance Analysis (Dept. 742)



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Mean Extra-cost for 742 Dept. Is 30% compared with Scheduled

“Solar” Simulator

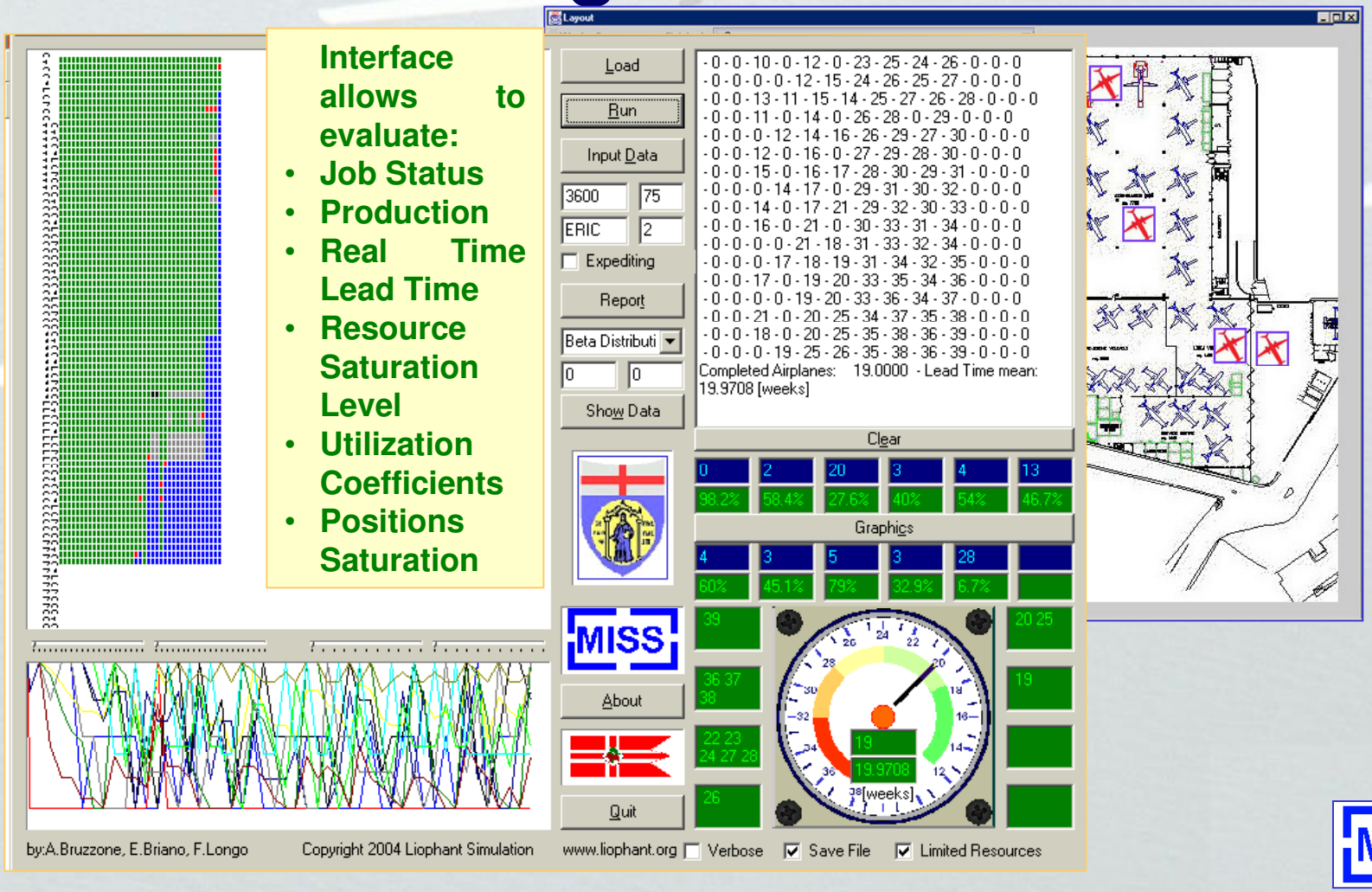
- VBA Simulator based on the real Job Completion Time
- Dates extracted from the Bills start and finishing time (CX)
- Mean Airplane Lead Time overestimated based on statitistical analysis

- Necessity to validate data and to develop a more detailed model

M.A.C.A.C.O. Simulator

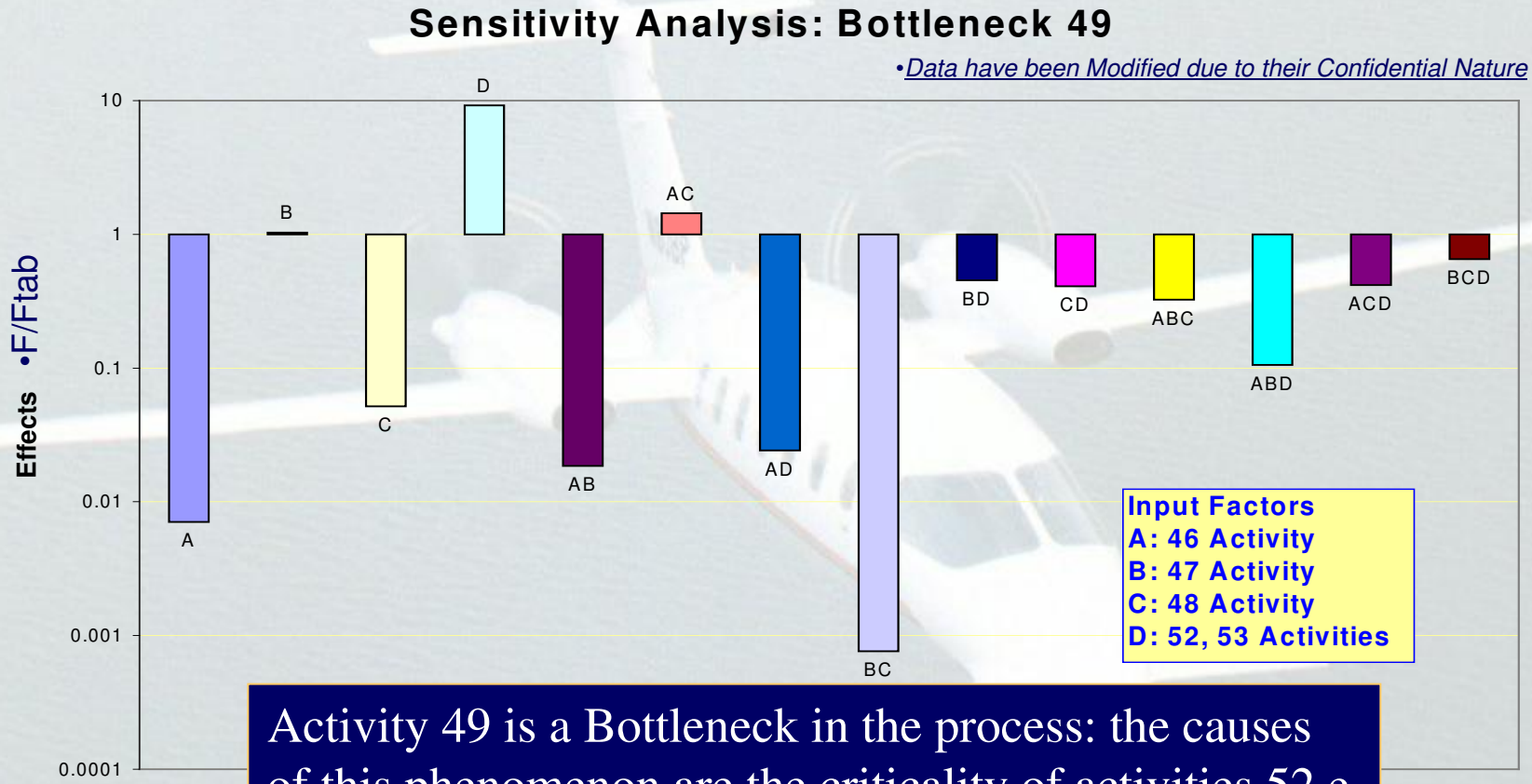
- Stochastic Discrete Event Simulator
- Job Duration-Based historical data (from Aircrafts NC 1077 to NC 1086) and experts estimation by beta distribution
- Production Process Model using concurrent PERT for each plane considering resources and constraints
- C++ built and animated
- Stochasticity provided by different probability distribution; deterministic case is also allowed
- Allows formulating What-If Analysis on Criticalities and Bottlenecks by variating Input Data

Modelling Air Craft Analysis for Construction process and Organization



- Interface allows to evaluate:
  - Job Status
  - Production
  - Real Time Lead Time
  - Resource Saturation Level
  - Utilization Coefficients
  - Positions Saturation

Bottleneck 49 Analysis (Test Press)



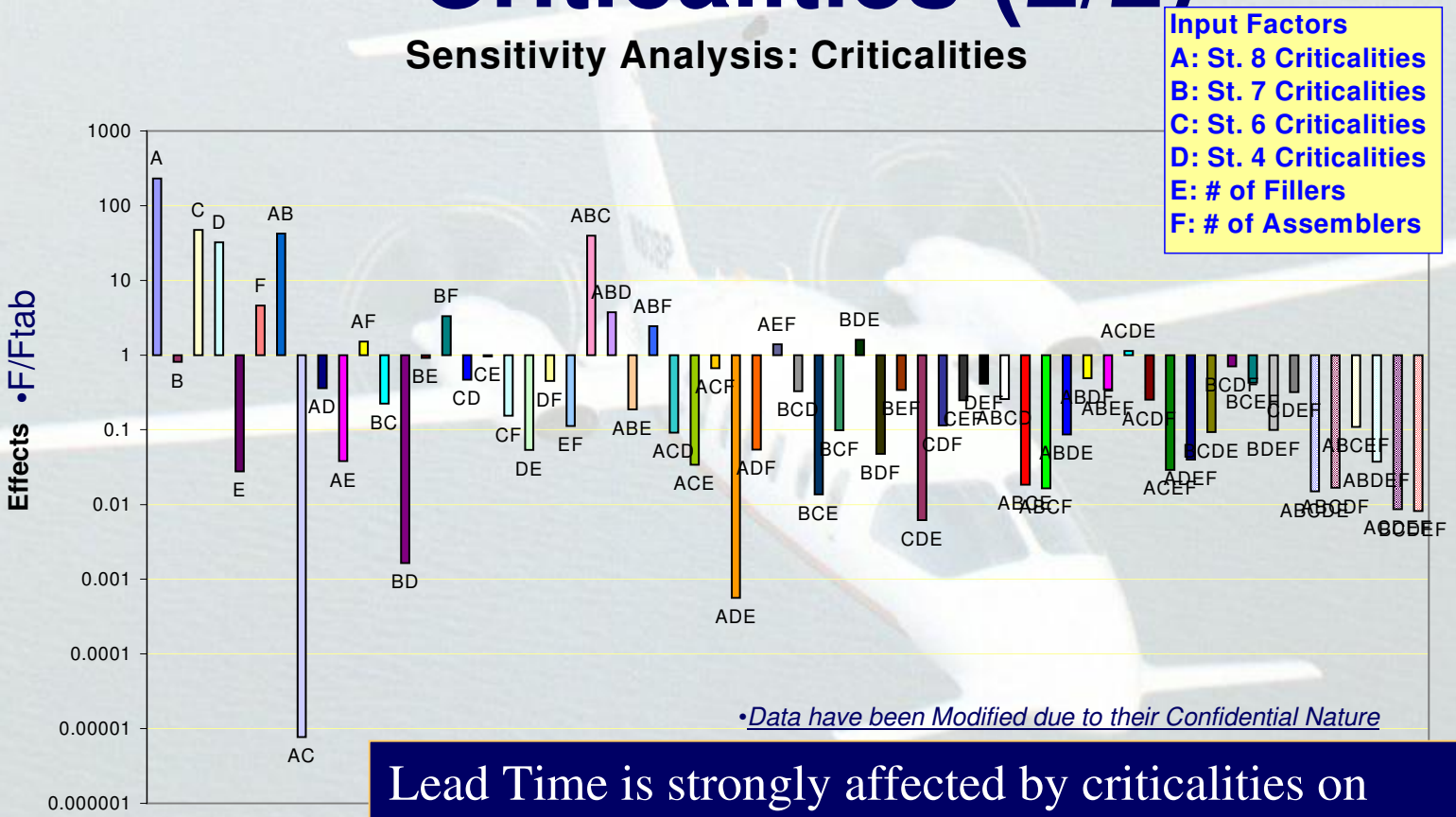
Activity 49 is a Bottleneck in the process: the causes of this phenomenon are the criticality of activities 52 e 53 and the influence of the sinergy of activities 46 and 48

Sensitivity Analysis on Criticalities (1/2)

- 2^6 Factorial Project based on Critical Path Activities Duration and on the Number of Fillers and Assemblers

FACTOR	MIN	MAX
A: CRITICALITY DURATION COEFF. Station 8	60%	140%
B: CRITICALITY DURATION COEFF. Station 7	60%	140%
C: CRITICALITY DURATION COEFF. Station 6	60%	140%
D: CRITICALITY DURATION COEFF. Station 5	60%	140%
E: N° OF FILLERS	4	6
F: N° OF ASSEMBLERS	14	18

Sensitivity Analysis on Criticalities (2/2)



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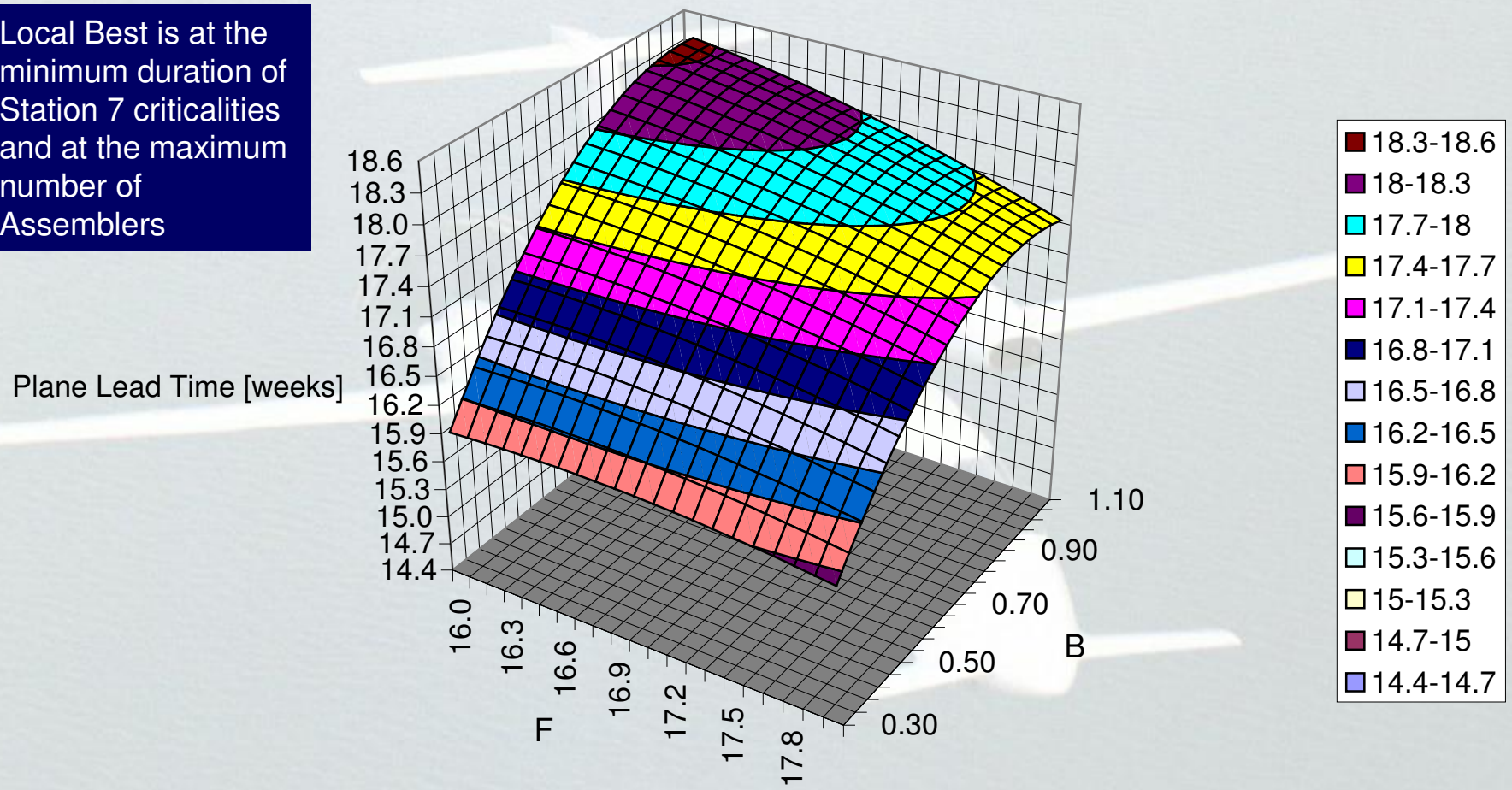
Lead Time is strongly affected by criticalities on Stations 8, 6 and 4

DOE & RSM Application

Response Surface Methodology: Lead Time

Local Best is at the minimum duration of Station 7 criticalities and at the maximum number of Assemblers



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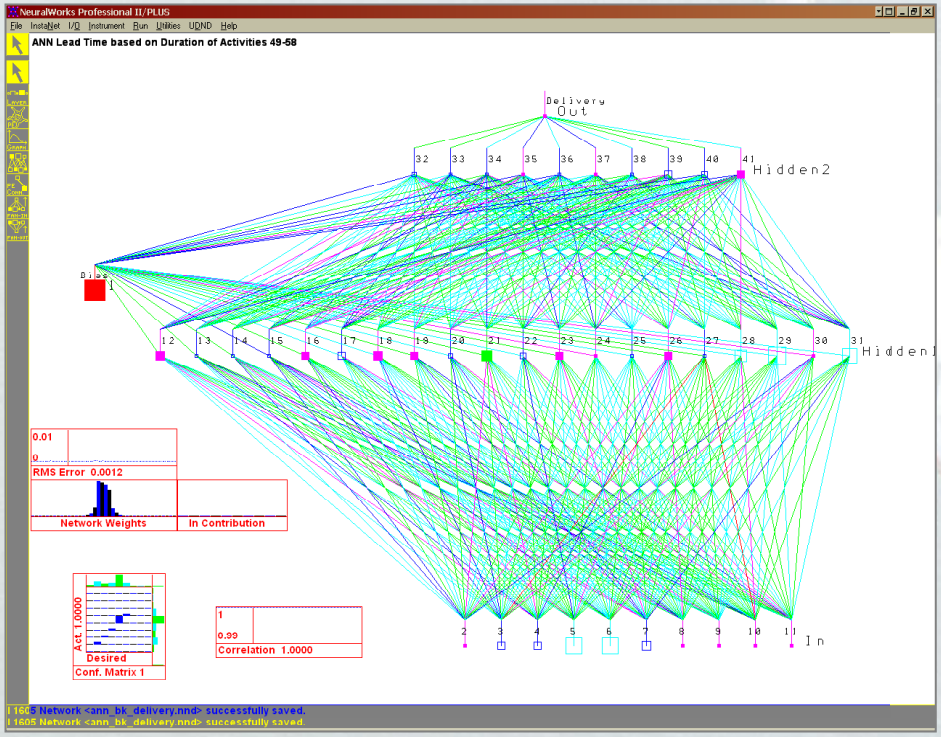
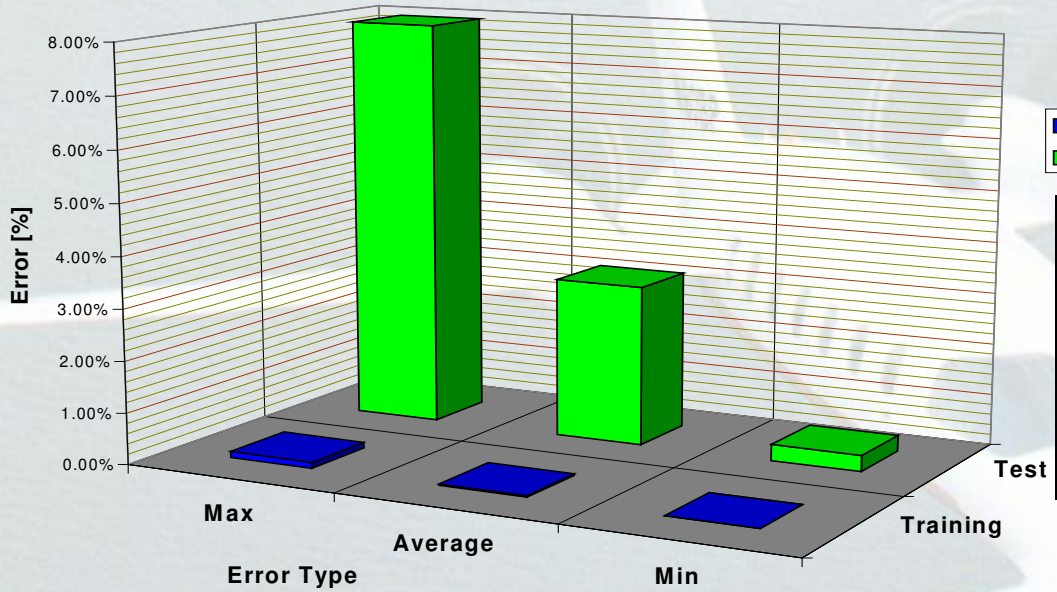
ANN Methodology Applied to the Plane Delivery Date Analysis



- Full Connected Feed Forward Architecture
- Back Propagation Algorythm
- 23 runs during Training
- 23 runs during Test
- 10 inputs: from job 49 to 58 (Station 6)
- 2 levels hidden layers
- 1 output: Delivery Date

ANN Methodology Results (1/3)

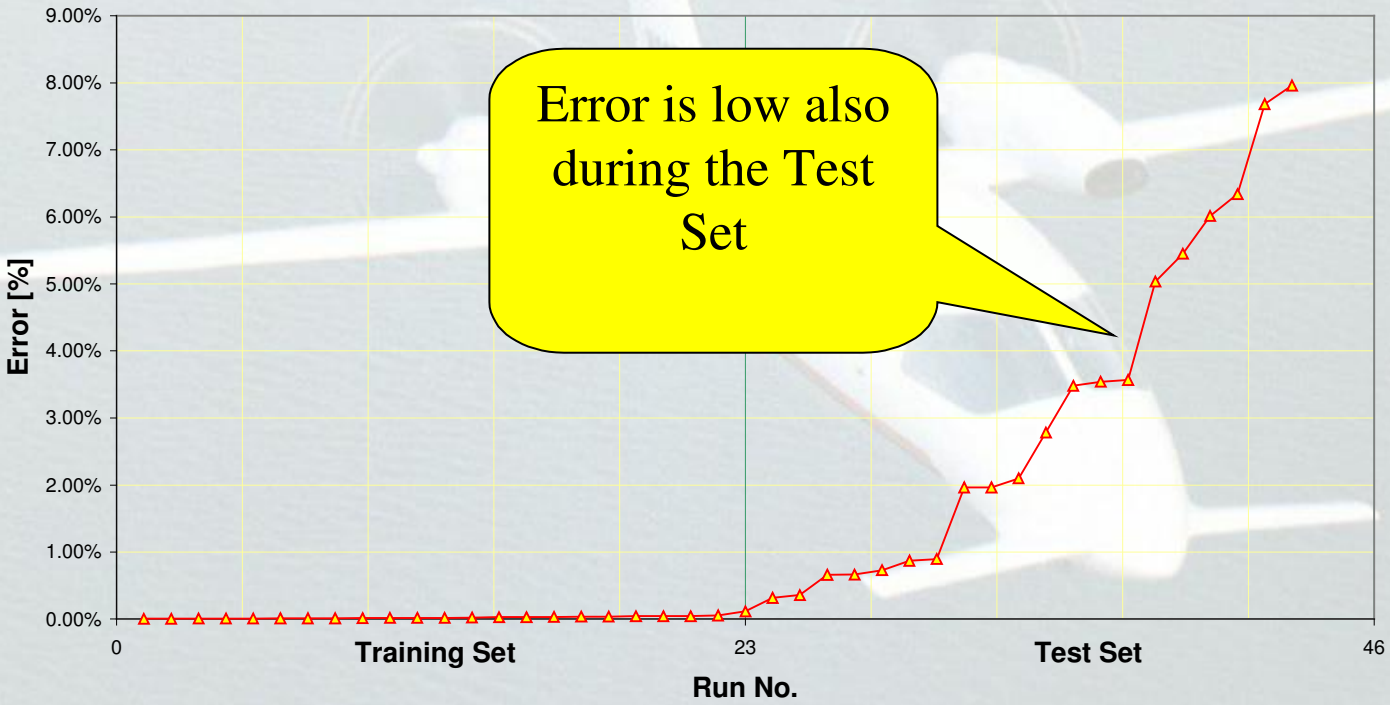
Errors for Predition of Plane Delivery in the Different Sets



SET	AVG ERROR	MAX ERROR
TRAINING SET	≅ 0	0.11 %
TEST SET	3.12 %	7.96 %

ANN Methodology Results (2/3)

ANN Error in Estimating Plane Delivery on Training/Test Data



ANN Methodology Results (3/3)

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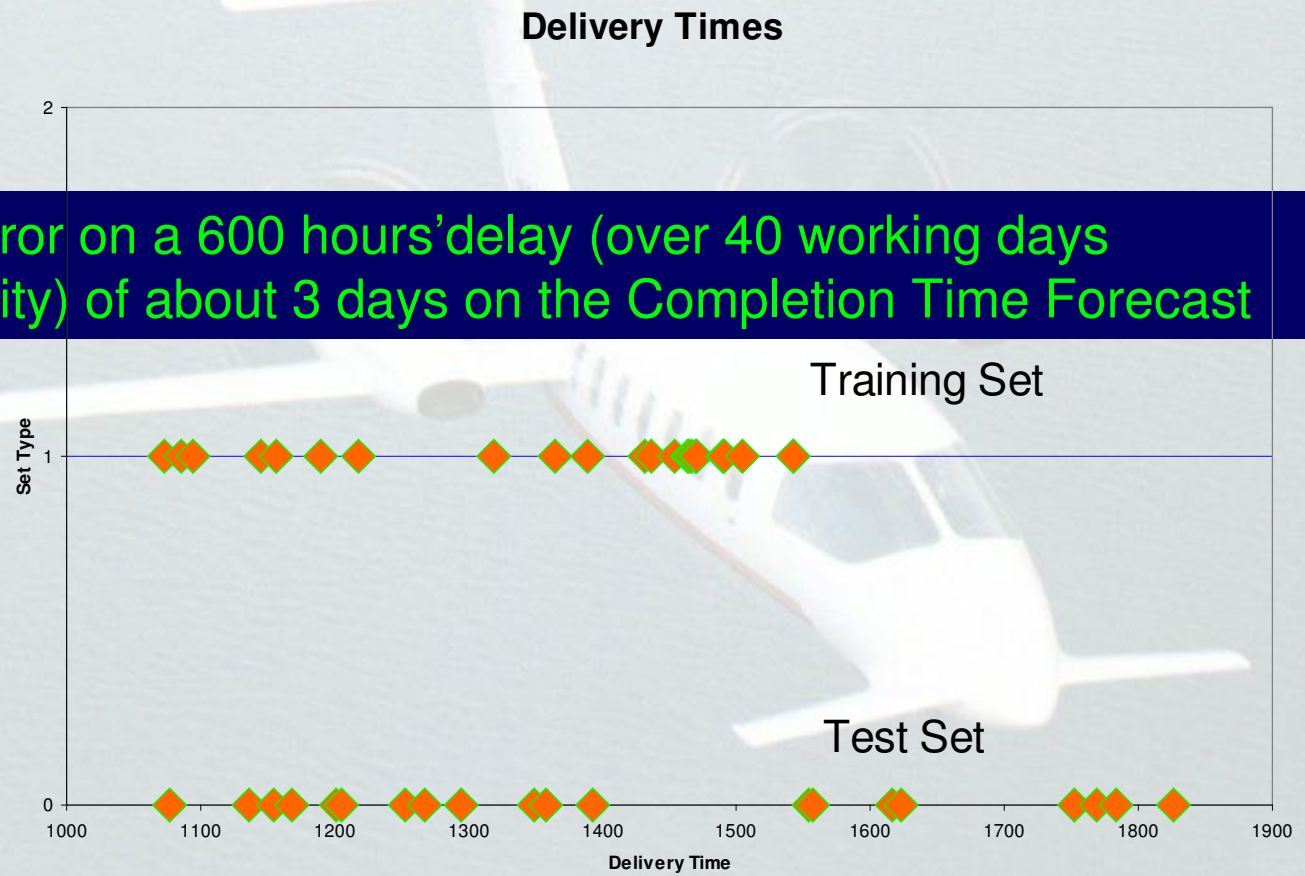

Conclusions

- Developed Simulation has been successfully validated on the P180 Assembling Line Scenario
- Simulation was able to identify a solution to guarantee 18 Weeks Lead Time without Manpower and Machinery Costs increase
- This Analysis has demonstrated the possibility of:
  - 15% WIP Reduction
  - 25% – 33% Off Planes inside the Assembling Line
  - Saving 21.5k€/Plane on financial fees