Abstract
The objective of this diploma thesis is to perform a complete risk assessment of an insulation blanket’s trial installation for an Airbus A320 aircraft. Technical and functional requirements have been described in order to understand the changes operated on the blanket. Through the study of non-conformities and graphs depicting deliverables versus time, quality issues and time delays are tracked in the best possible way in order to identify risks. Appropriate risk tables and matrix were chosen as a frame for this assessment. Risks associated with the trial installation of the new insulation blankets were then assessed, prioritized according to their criticality and placed automatically on a risk matrix using a VBA program. Mitigation actions were finally proposed and validated to achieve the main objective of this risk assessment: to annul the occurrence and to decline the impact of all potential unforeseen turns of event described in this report.

1 Introduction

1.1 Purpose of the report
Risk management is a logical and systematic approach to identify, assess, report and mitigate risks linked to a particular situation, project or programme [1]. To secure the continuity and the progress of an industrial project as well as improving its feasibility given time, cost and quality constraints, it is essential to manage the risks connected to this project. A risk study is compulsory in order to clearly define all the parameters that can endanger the right accomplishment of the project’s objectives. Risk management cannot be separated from the global project management process because a risk description leads to actions that should be taken to mitigate them. In addition, it is more efficient to control risks while having a global view of the project, rather than isolating them from the project progress [2].

1.2 Scope
In order to increase its thermal and acoustical efficiency, while reducing its total weight, a new insulation blanket is planned to be installed on single-aisle planes by the end of 2012. New materials are used and consequently the physical properties of the blankets, as its density and its geometry, change. Before the serial implementation of the new insulation blanket, a test-plane has been defined in order to perform and to experiment in real time the new blanket’s installation. This trial installation will occur on an Airbus A320 aircraft, listed under the name MSN 5316. The aft fuselage of this plane is assembled in Hamburg, and all the different sections will be put together in the Final Assembly Line (FAL) in Hamburg. New blankets will be installed on the aft fuselage of the plane MSN 5316, then de-installed and old blankets will definitively be implemented on all sections. An A320 plane is the generic plane of the A320 family, so it is logical to think that issues noticed during the trial installation would be the same with the other standards (ST), which are the ST2-A321, ST3-A319 and ST4-A318.
1.3 Objectives

The trial installation of the new insulation blanket for Airbus single-aisle planes is used as a first industrial implementation in order to analyze occurring issues and to link them to risks previously identified. Known and listed difficulties can then be foreseen and mitigated before the serial implementation. The objective of this study is to describe all the risks and to select the most appropriate method to assess and to mitigate them accordingly to the roles and responsibilities of the project’s stakeholders. Risks linked to the trial installation can be divided according to their internal connection if they have an origin through Airbus organization, or external affiliation if they come from the suppliers or subcontractors’ work. This report focuses first on general quality and time tracking methods before deepening into the details of each risk and possible associated mitigation action.

2 Functional Requirements and General Risk Tracking Methods

It is not possible to perform a risk assessment if the technical background of the project remains unknown. The modification of the new blanket follows an accurate process that permits to delimit the frame of the functional changes and to validate them by the project’s stakeholders. Given its cost and its impact for Airbus and customers, the insulation blanket’s improvement is treated as a "major modification", meaning that airworthiness authorities take part in the final validation process.

2.1 Modification Opening, a necessary configuration management step

A major change into a plane requires the approval from the different stakeholders involved in the launch of the project. To do so, the detailed and complete definition of the technical changes, their costs and criticality, the first impacted plane named Point of Embodiment (PoE), and the project’s duration should be approved through a formal configuration management frame called "Modification" or "MOD". Thus, a project is completely launched after a "MOD Opening" and changes are totally integrated in the plane configuration after the "MOD closure". A single project can be linked to different MODs according to the way work-packages are split.

2.2 Summary of the technical changes

The insulation blanket can be divided into two distinct parts. The first one, called primary insulation, is the most external one and is fixed directly on the fuselage’s structure. It is itself divided into a superficial layer called foil, and a glass wool. The second one, called secondary, is the most internal one and is linked to the cabin linings. The trial installation focuses only on the primary insulation, and not on the one attached to the cabin linings.
Figure 1: Post-Modification thermal and acoustical insulation of an A320 [3].

Between the pre and the post-modification, the main changes are operated on the density of the used glass wool and on areas where a third inch of glass wool is added to increase the acoustical efficiency of the insulation, as described table 1. Based on a A320 plane, the frames are listed from C0 to C70, and the stringers symmetrically from P1 to P38 and from P’1 to P’38, as illustrated figure 1. The use of new materials permits a drop of 30kg in the weight of a whole plane’s insulation.

<table>
<thead>
<tr>
<th>Pre-MOD</th>
<th>Post-MOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frames</td>
<td>Strings</td>
</tr>
<tr>
<td>whole fuselage</td>
<td>P38 to P’38</td>
</tr>
<tr>
<td>whole fuselage</td>
<td>P11 to P21</td>
</tr>
<tr>
<td></td>
<td>P1 to P’21</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Table presenting the insulation blanket changes on an A320 plane between the pre and the post-modification.

For a given plane, new insulation blankets are implemented on the whole fuselage. However, the forward fuselage is assembled in St-Nazaire in France, and the aft fuselage in Hamburg in Germany. The extremity of each half of the fuselage, which corresponds to the distance between the really last frame of the section and the one before, is let free of blanket in order to perform the installation only when the two fuselage parts are put together in the Final Assembly Line, which can be in Hamburg, Toulouse in France or Tianjin in China. Everything is defined to finally have a perfect continuity of the blanket once the two fuselage parts are assembled together.

All the technical changes, from the pre to the post-modification, are listed in a specific document that gathers and describes the impacts of these changes on the different organizations implied in the project [4]. It is called a Technical Repercussion Sheet (TRS). A MOD Proposal (MP) carries a TRS, and several MP are associated
in this project to one MOD. The objective is to separate in different clusters the plane areas impacted by the modification. Regarding the risk assessment, it is thus possible to focus firstly on each MP taken separately from the others before any transversal study. This is however not what has been done in this case because the trial installation occurs only on the aft fuselage of the plane MSN 5316.

All the risks follow Time, Cost, Quality, Performance concerns, and the next paragraph focuses on the Quality side of the risk management in order to explain how technical manufacturing issues are classified. The understanding of potential issues and outstanding work to be done to correct them is essential to define mitigation actions described paragraph 6. For confidentiality reasons, Cost tracking is not described in this report.

2.3 Quality tracking: Non-Conformities (NC) observation

A risk leads to the possibility for a product to be different from the expectations. It is an abstract notion that is however directly linked to the more observable concept of an "unforeseen turn of event". A NC is a quality management term referencing to an observable difference between what is expected and what is done in reality. This is why most of the risks, generally the ones linked to the manufacturing field, or more generally to an industrial project, refer to possible non-conformities. Non-conformity is synonym of a defect and it can be defined as minor, major or critical. Concerning the insulation blanket, the ranking of NCs is done according to three classes, allowing knowing who has to handle the problem and to check the repairing. Definitions of these categories, additionally to practical examples are described in the table 2 [5].

<table>
<thead>
<tr>
<th>Status of the Non Conformity</th>
<th>Example related to the insulation blanket</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class 1</strong></td>
<td>Quality decides without reporting to Engineering concerning the issue. The airworthiness, the thermal or acoustical quality of the blanket is not affected. However there is a visible imperfection that has to be noticed. No rework should be performed and documentation is not mandatory. For example some felt-tip pen traces are found on the blanket, without any damage on the covering foil.</td>
</tr>
<tr>
<td><strong>Class 2</strong></td>
<td>Quality decides on behalf of Engineering and internal documentation is mandatory. Most of the NCs concerning the trial installation belong to this category. All the damages, tears, cuts on the covering foil, below a certain length decided by numerous quality specifications documents, are treated under this class. A rework has to be done in order to ensure that the blanket keeps its acoustical and thermal properties. This rework follows strict specifications detailed and approved by Engineering.</td>
</tr>
<tr>
<td><strong>Class 3</strong></td>
<td>Engineering decides about the blanket’s sustainability. The non-conformity is significant and in most cases the blanket has to be changed. For example, due to wrong manufacturing processes, the covering foil can be damaged because of its adherence to the plane’s structure. In this case, no rework is possible and a new blanket has to be installed. However, it can be noticed that given the thermal and acoustical properties of the blanket, it is unlikely that problems occurring during its installation would lead to class 3 non-conformities.</td>
</tr>
</tbody>
</table>

Table 2: Direct application on the insulation blanket of the three possible statuses of a non-conformity.

Risk management foresees all the issues that could lead to NCs. By identifying potential risks, solutions to solve non-conformities are anticipated, which is more time-efficient than trying to solve a NC after its observation. The blanket’s trial installation aims to focus on these NCs because they report damages that can occur during any of the blanket’s installation, and not only the first one. If root causes related to these NCs are found, it is then possible to annul them, or at least to decrease their occurrence during the serial implementation. It should also be noticed that the particular attention paid during the first installation is not realistic compared to the normal working conditions on a serial aircraft. It can thus be considered that damages reported during the trial installation are the minimum possible damages potentially performed during a serial implementation. Nevertheless it is important to understand that some unforeseen events cannot be observable under the report.
of a NC. For example, a time delay involves additional costs or the necessity to postpone an installation, but not an observable NC on the blanket. That is why other means are used to track these potential delays, belonging to the Time management side, as curves displaying deliverables versus time.

2.4 Time delay tracking: S-curve Deliverables versus Time

This section’s objective is to present the work done on the building and the update of S-curves displaying the number of achieved deliverables versus the time. These curves are an efficient means to track time delays by checking which deliverables are late or in advance compared to the baseline fixed at the beginning of the project, i.e. when the MOD is open. It is a possibility to identify if there is a risk that the project might not be implemented on time because of late deliverables concerning for example the new blankets’ design or manufacturing. However, any risk connected to NC observable during the blankets’ installation cannot be detected by the use of these S-curves.

2.4.1 Academic mathematical definition of an S-curve

An S-curve is a mathematical model that shows the introduction, then the development and finally the maturation of certain parameters versus the time. It tends to be flat at the beginning and at the end of the time line because, in relation to the new insulation blanket project, no more deliverables are achieved, while it is steep during intermediary times when the number of completed tasks reaches its maximum [6]. The quick increase of the achieved tasks number during intermediary times does not reflect any compression of the workload. It is simply the result of a necessary duration for any task to be performed and it would thus be unusual to see a great amount of work achieved at the beginning while technical modifications are not clearly defined, or at the end of the project while the modification should be definitively ready to be implemented into the plane. Mathematically, the function \( f : t \mapsto \frac{1}{1+e^{-t}} \) visible figure 2 is the closest of S-curves often observed in project and risk management fields.

![Figure 2: Graphical representation of the function \( f : t \mapsto \frac{1}{1+e^{-t}} \), model used for an S-curve.](image)

2.4.2 Automatic construction of the S-curve Deliverables versus Time

A complete graph depicting the evolution of achieved deliverables versus the time presents two curves. The first one, always drawn in blue in this report, illustrates the number of completed tasks according to their end-date decided at the beginning of the project. This curve is called the baseline. A task is considered as finished when its decided end-date is over.

A second curve, in red, depicts the number of completed tasks regarding their actual/real end-date, or considering an end-date different from the one forecasted at the beginning of the project in the baseline. The task is then considered as finished when its actual/re-planned end-date is over. The drawing of these two curves is ensured by adding in the project’s schedule a difference between the end-date forecasted at the beginning of the project and the actual/re-planned end-date. This difference is a means to compare the actual or the future achievement of a task with the baseline decided at the beginning of the project. For example, during the time of the definition drawings’ design, if a delay is noticed, it means that some drawings might be missing for the beginning of the manufacturing of the blankets. This is a risk that has to be noticed, listed and then mitigated.

By drawing on one graph these two curves, previous and future deliverables achievements are tracked regarding established or forecasted delays. Risks can therefore be reported using time-data to prove their relative importance. This method is used within the new insulation blanket project to determine if there is a risk that time delays may have an influence on the trial installation.

Presented figure 3, five tasks are used as an example to show how the blue and red curves visible figure 4 are
drawn. An actual/re-planned end-date different from the forecasted one is written in bold letters to ease its readability.

<table>
<thead>
<tr>
<th>Task</th>
<th>Beginning</th>
<th>Forecasted end</th>
<th>Actual/re-planned end</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1</td>
<td>01.03.2012</td>
<td>01.04.2012</td>
<td>01.04.2012</td>
</tr>
<tr>
<td>Task 2</td>
<td>01.04.2012</td>
<td>01.05.2012</td>
<td>01.05.2012</td>
</tr>
<tr>
<td>Task 3</td>
<td>01.05.2012</td>
<td>01.06.2012</td>
<td>15.06.2012</td>
</tr>
<tr>
<td>Task 4</td>
<td>01.06.2012</td>
<td>01.07.2012</td>
<td>01.07.2012</td>
</tr>
<tr>
<td>Task 5</td>
<td>01.07.2012</td>
<td>01.08.2012</td>
<td>15.07.2012</td>
</tr>
</tbody>
</table>

Figure 3: Table showing the forecasted and actual/re-planned end-dates of five arbitrary tasks.

Figure 4: Curves of Deliverables versus the Time drawn according to the table presented figure 3.

The graph depicted figure 4 is drawn automatically using an Excel Macro computed in VBA language given the data from the figure 3. It is remarkable that at the 1st of April and the 1st of May, the forecasted and the actual/re-planned end-dates match. Therefore the blue and red curves merge. However, the task 3 has a forecasted end-date prior to the actual end-date. So at the 1st of June, a blue deliverable can be incremented, but not a red one given the fact that the actual end-date is the 15th of June. This is exactly the contrary for the increment of the task number 5, which has a forecasted end-date posterior to the actual/re-planned end-date. The red curve is thus incremented with a red deliverable the 15th of July 2012 and the blue curve only the 1st of August 2012. The graph finally displays a differentiation between the blue and the red curve if the forecasted and actual/re-planned end-dates do not match. A control of the critical phases of the project is hence possible and the related risks can be established.

2.4.3 Application of the S-curve principle to the new insulation blanket project

As it was described previously, the realization of S-curves is totally linked to the schedule's construction under Microsoft Project. The one used for the implementation of the new insulation blanket shows among others the beginning date, the forecasted and actual/re-planned end-dates of the main project tasks, as visible figure 5.
Figure 5: Partial schedule of the new insulation blankets project.

Using this schedule, the S-curves of the deliverables versus the time can be computed to obtain the graph illustrated figure 6.

Figure 6: Curves of deliverables versus time drawn given information from the schedule of the new insulation blanket project.

It can be noticed figure 6 that between the 16th of August and the 16th of April 2012, the number or achieved tasks is inferior to the number of completed tasks forecasted for this period of time. There is as a result a delay which is corrected, and even inversed, between the 16th of September 2012 and the 16th of April 2013 when the number of achieved deliverables is planned to be superior to the baseline. Using these curves, it is possible to detect that some actions cannot be performed on time, which could lead to additional costs or a shift of the first impacted plane by the modification. The first installation of the new insulation blanket is directly linked to key-deliverables that should be performed on time. If the schedule and thus the S-curves are accurate enough, all the risks related to potential delays can be noticed, assessed and then mitigated.
3 Methodology of the risk evaluation used for the trial installation

3.1 Risk Management Process

Risk management is a systematic process that deals with the identification, the analysis, the treatment, the mitigation and the communication of all time, cost, quality and performance parameters that can affect the project’s progress. The objective is to obtain a clear status of the risk importance regarding its level of impact and of occurrence and to decide which actions should be taken to minimize them. A succession of steps has to be followed, as summarized figure 7.

- The determination of potential issues, or risks identification, associated with the choice of the risk management tool, is the first step of the risk management process.
- Then, during the risk analysis phase, a status is attributed to each risk in order to define its level of importance. This is also called the risk assessment phase in which a prioritization of the risks is done using different charts or graphs. At this level, more or less advanced programs are used to present a clear comparison between the different risks status.
- The risk evaluation is the research of mitigation actions which should be taken to ensure suitable responses in order to cancel risk occurrence and to decline its impact [7].
- Finally, risk reporting is the best means to define which risks are residual and should still be taken into account, and which one are totally mitigated. It can also be considered as a communication solution to minimize the risk occurrence thanks to a public awareness of the encountered issues.

![Figure 7: Risk management cycle.](image)

It is eventually essential to notice that risk monitoring and communication have to be considered during the whole risk management process given the fact that they interact with each step of the process in order to increase the general efficiency. In addition, a bottom up and transverse risk analysis should be performed because of risks interdependencies. The trial installation of the new insulation blanket involves a partnership between Engineering, Manufacturing, Procurement, Quality and Project Management departments. In this case, the Risk Management has to be performed by the Project Management office in order to have an effective global and transverse view of all the interdependencies that may exist between different risks.

3.2 Risks’ criticality

In order to decide which attention should be paid to a particular risk, its criticality, notion close to a level of importance, is defined according to its probability of occurrence and its potential impact [2]. The criticality creates a coupling between two parameters that can be evaluated separately in order to associate one risk to one value. This is the first prioritization step of the risk assessment.

\[
\text{Criticality} = \text{Probability of Occurrence} \cdot \text{Impact (regarding Time, Cost, Quality)}
\]  

(1)
It seems firstly that qualitative arguments or personal subjective judgments permit to evaluate the two parameters "occurrence" and "impact", however the study of the cost and time which can be lost gives quantitative arguments and thus the criticality of a risk can result from a quantitative discussion.

The figure 8 presents how the criticality of a risk can be evaluated given, on the horizontal axis, the risk impact and on the vertical axis the risk probability of occurrence. Risks impacts are categorized in terms of cost, time (schedule) and quality (performance). A probability scale can be defined to assess if the risk are more or less chances to materialize.

![Figure 8: Risk Criticality Assessment Matrix](image)

Given the fact that time delays and an unacceptable quality can lead to a costly rework performed on the insulation blanket, it is possible to budget and thus to obtain quantitative parameters on the risk status. Additionally, the share of personal or historical experience between the stakeholders of the project leads naturally to have a qualitative opinion on the risk’s probability of occurrence. Qualitative and quantitative arguments have the same objective: to get the most accurate evaluation of the risk’s criticality.

### 3.3 Objectivity of the risk measurement

The previous paragraph raised the question of a possible objectivity in the risk assessment. Following the same consideration, Bernoulli developed in his book *Exposition of a new Theory on the Measurement of Risks*, in 1768, the possibility for a risk to be mathematically described. Given the fact that the level of occurrence of a risk corresponds to a probability, Bernoulli tried to find out with which precision this parameter can be known. A risk, called by Bernoulli "expected value" $R$ is the sum of the events consequences $C_i$ multiplied by their probability $p_i$ [8]:

$$R = \sum p_i \cdot C_i \quad (2)$$

Bernoulli explains that using an appropriate scale, the probability of occurrence $p_i$ can be attributed to each risk. In addition, the cost of an unforeseen turn of event can be calculated, so a price can be attributed to each $C_i$.

In the case of the trial installation, a value, which can be assimilated to a price to pay, can finally be attributed to the total risk $R$. However, a given price has a relative importance depending on the concerned people or
project. That is why Bernoulli recommends that the value of any unforeseen turn of event should be based on its utility instead of its price. Unlike a price to pay, the utility of an unforeseen event should be universally accepted.

It is thus understandable that a test-installation of an insulation blanket encounters unforeseen events which can be budgeted. Unfortunately, due to the fact that the utility of these unforeseen events is not analyzed, the criticality of the risk cannot be universally accepted, according to Bernoulli’s theory. The risk assessment of the trial installation can only be considered and approved by the project’s stakeholders because the criticality calculated for each risk can appear negligible for anyone having an outside view on the project. It proves also that a complete objectivity of an industrial risk assessment cannot be reached because the necessary costs calculations of each risk’s criticality prevent the risk assessment from being universally accepted [8].

3.4 Selection of the risk template

Different departments use generally distinct tables to perform the risk identification; nevertheless some categories remain essential and are present in every type of risk tables in order to ensure a minimum of accuracy in the risk assessment. In this study, the figure 9 illustrates the chosen template that is used to identify, describe and mitigate the risks associated to the trial installation.

![Figure 9: Risk Monitoring Table to be filled for the risk assessment.](image)

Regarding the parameters "impact" and "occurrence", a value is attributed depending of the chosen status (from zero, to low, then medium, high, critical and maximum). Then a simple program multiplies for each line the value attributed to the category "impact" with the one of the category "probability" in order to get a value for the category "criticality". Depending on this value, a color is defined for each risk. This is the direct application of the mathematical formula described section 3.2. As soon as the risks are listed in the table, they can be placed on a risk matrix to ease their prioritization.

3.5 Use of an Excel Macro to update a risk matrix

The interest of a risk matrix is to get an immediate view of all the risks and their level of importance on a chart. Due to severe time constraints, it is essential to classify risks depending on their potential consequences on a project. A simple table presenting the level of impact and of occurrence for each risk taken separately is unfortunately not efficient enough to have a clear understanding of which risk should be considered first. This ineffectiveness comes from the decoupling of impact and occurrence, and the lack of classification between different risks. Occurrence and impact are fundamentally different and it is important to first make the distinction between these two qualifying notions. It is obvious that while a risk has a low impact, its level of occurrence can be high, and vice versa. However, the coupling of impact and probability on a suitable risk matrix permits to obtain the necessary risk prioritization.

A VBA program is implemented to define the risk status according to its level of impact and occurrence and to present it automatically on a matrix. All the risk statuses are then reported automatically and it becomes convenient to observe on the matrix which risk is the most critical and should be considered with the highest importance.

4 Assessment of the risks linked to the trial installation

The objective is to establish a first analysis and listing of the risks connected to the first industrial implementation of the new blanket.
4.1 Risks leading to observable non-conformities

This paragraph lists the risks impacting directly the manufacturing department since they can lead to non-conformities observable during the trial installation. If a problem is detected, some rework will have to be done, or a new blanket design will be performed to assure its correct implementation into the aircraft.

- Due to the new flexibility of the insulation blanket, it can be difficult to maintain it close to the plane’s primary structure implying that the distance between the blanket and hydraulic/electrical pipes and cables could be too small. This required distance is defined by specifications established to prevent the cables and/or the pipes from any damages due to the heat emitted by the electrical cables or the friction between the blanket and the pipes. Cables and pipes are put into the plane after the blanket; it is thus difficult to foresee if there will be a suitable distance when the blanket is installed. This generates the possibility to de-install the pipes and cables, and then the blanket to re-install it with more precautions in order to contain its flexibility. Then the cables and/or pipes can be re-installed again.

- Due to the new flexibility of the blanket, the installation could be less easy than in the past. An increase of the new blanket’s flexibility does not necessarily mean an easier installation because it has to be maintained close to the plane’s structure. That is why there is a risk that a material change leads to difficulties during its installation.

- Small differences regarding the position of the fixation holes in the blanket and in the structure’s brackets can be detected. It would affect in the best case the easiness of the blanket’s installation. In the worst case the fixation of the blanket could not be done because of wrong holes positions. Even if the probability of occurrence is low because the new blanket’s design is similar to the previous model, the impact is high.

- Accidental deteriorations may occur during the installation. Within manufacturing hangars, people are used to working with a certain type of insulation blanket, with a particular foil robustness. In case of a difference in robustness between the old and the new blanket, some damages can accidentally be performed.

- The new insulation blanket might not be well adapted to the geometric configuration of the windows. The installation of an insulation layer around the windows is always more critical than for the rest of the fuselage. That is why there is a risk that the new blanket might present difficulties to be properly installed.

- During the blanket’s installation, adhesive marking tape is used. However, tests performed on the blanket showed that the marking tape, which has to be removed from the blanket after its installation, damages the foil. Thus this tape cannot be used otherwise some rework will have to be done.

4.2 Risks related to global process of the trial installation

The risks listed below are not observable under the form of NCs. They are linked to time and cost tracking measures and thus affect the right establishment of the trial installation.

- There is a risk that the new blankets are not delivered on time for the beginning of the trial installation, which should be done between the 24th and the 30th of July 2012. This event can be the consequence of a late adjustment of the plane impacted by this trial installation and thus a late order done to the supplier. This order should be done at least two weeks before the installation, which means before the 10th of July 2012. If the initial plane targeted for this installation changes at the last moment, it might be too late to order and to receive the new blanket on time. A time delay of this type has a high impact on the trial installation, however its occurrence is low due to a serious forecast performed months ago to target a suitable test-plane.

- In June 2012, there is a 3-day delay in the major components assembly line in Hamburg, implying the impossibility to plan precisely the trial-installation’s date in July 2012.

- The risk linked to the scheduling of the trial installation implies another one regarding the booking of resources in order to perform the installation. People should be warned in advance in order for them to plan their working days.

All the risks presented in the two previous paragraphs are listed in the table 10 which agrees with the chosen template presented figure 9.
Figure 10: Risk Monitoring Table presenting all the risks linked to the trial installation.

5 Visualization and analysis of the risk matrix

5.1 Complete visualization of the risks

The risk matrix is a chart that displays the impact on the horizontal axis and the probability of occurrence on the vertical one. The objective is to get a prioritization of the risks in order to decide which ones have to be considered with the highest importance. Different colors, from green to red with yellow and orange intermediaries are used to have an easy visualization of the risks. To one point corresponds one risk and all the risks listed in the table presented figure 10 are placed on the risk matrix. It is then easy to notice which risks are situated in the red area and which ones should thus be mitigated first.

The VBA program permits to have an automatic update of the risks’ position on the matrix if there is a change of status in the table. The user only has to concentrate on the best mitigation action for a given risk, and if its impact or probability of occurrence changes, it will accordingly be moved on the risk matrix. This is done by an attribution of a certain value to each possible status: for example the status "zero" will get 0 point (even if a risk with zero impact is not a risk any more), the "low" one 18 points and so on until the "max" status which has an attribution of 354 points. The same attribution of points is done for both the risk impact and occurrence and it can be directly reported on the horizontal and vertical axis of the graph, as depicted figure 11. These points are directly linked to the risks’ coordinates on the matrix.
5.2 Analysis of the risk matrix

It is firstly remarkable that the risk matrix is not symmetrical concerning the colours presentation. This comes from the fact that the risk impact should be considered with a higher attention than a risk probability. If a risk has a low impact but a high probability, it means that it is possible to cope with the unforeseen turn of event, and the fact that it will often happen does not change the fact that it is still manageable. All the risks are present in the risk matrix, and the number eases their readability. As visible figure 11, the risks that should be mitigated first are the ones numbered 2, 8 and 9, concerning the distance between the blanket and the hydraulic/electrical pipes and cable, the availability of the aircraft MSN 5316 at the right moment in the manufacturing line, and the availability of the required resources to perform the test. The risks 8 and 9 are clearly linked together, so a mitigation action for the first one will imply a decrease of the second one’s criticality.

Nevertheless other risks such as the ones numbered 1, 3, 5 and 7 are situated in the orange area. This means that they should definitively be taken into account. Nevertheless, the probability of occurrence between the risk 7 and \{3; 5\} is not the same, implying complete different actions to mitigate them, as presented in the next section. The risks 4 and 6 have a low probabilities of occurrence and a medium impact. They are classified as "green" and mitigation actions should involve the possibility to completely cope with these risks.

6 Validated mitigation actions

The objective of a risk assessment is to gather all the required information to find and describe mitigation actions that ideally permit to annul the risk probability of occurrence and to decrease its impact. From an engineering and project management point of view, there is no point in describing risks without establishing mitigation actions. Thanks to the contribution of the Design Office, the Manufacturing, Engineering and Project Management departments, actions were found to mitigate the accepted risks; they are listed below and depicted in the Microsoft Excel table presented figure 12.
If a cut or damage occurs during the blanket’s installation, referring to the risk number 1, a "repair kit" might be used. It can be assimilated to a band of tape with a chosen length and width certified by the Engineering Office to ensure that the damaged blanket keeps its acoustical and thermal properties after repairing. This does reduce neither the risk impact nor its probability of occurrence because nothing is done upstream to prevent the blanket from being damaged.

To mitigate risks relative to the windows configuration, difficulties of installation and the distance between the blanket and the hydraulic/electrical pipes and cables, i.e. the risks numbered 2, 4 and 5, an outstanding work can be necessary in order to add fix points or to contain the blanket’s flexibility. If this action is well coordinated, it reduces the risk impact and its probability of occurrence because workers will gain experience on how the blanket should be installed in critical areas.

The work from the Design Office should ensure that the fixation and the blanket’s holes match, so nothing can be done upstream. Therefore the only way to mitigate the risk number 3 is to forecast that a new manufacturing process might be required to ensure an appropriate fixation.

The only external risk to mitigate is the number 6 regarding the possibility to have a late delivery from the supplier. The probability of occurrence is mitigated by an order done soon enough in order for the supplier to manufacture and to transport the blankets to Hamburg on time.

Damages on the foil due to the use of marking tape, listed as risk number 7, is mitigated by the information sent to all the concerned persons that this marking tape cannot be used on the new blanket’s foil. This note should annul the risk occurrence but the success of this mitigation action relies on the correct and complete distribution of the information, which cannot be ensured.

The risks 8 and 9 are absolutely linked, thus a mitigation action for one of them is also valid the second one. If the schedule is known with more accuracy, in particular for the plane MSN 5316, the probability of occurrence of these risks are decreased.

It can be noticed that none of these mitigation actions permits to cancel both the risk impact and its probability of occurrence. All risks can thus be considered as residual and remain into the risk management cycle. Each mitigation action should be attributed to one person who will be responsible to perform it or at least to control that the risk is properly mitigated by other stakeholders. The idealistic case of an annulment of the probability of occurrence and a minimum impact is rarely reached, but costs depend so much on time delays and outstanding work that it is worth spending time in finding and performing these actions.
7 Conclusion

This study shows that the risk assessment of the blanket’s trial installation results from the understanding of technical changes and the tracking of time and quality parameters observable under the analysis of S-curves depicting achieved deliverables versus the time and the forecast of all potential non-conformities. A cost tracking is also necessary to ensure that the budget is not exceeded, but remains more confidential. The modification of the glass wool density and the blanket’s superficial foil implies the possibility to detect NCs during the trial installation such as cuts, superficial damages or difficulties of installation. At the same time, delays in the manufacturing line imply difficulties to book enough available resources in order to perform the installation on time. To be useful, it is essential that this assessment describes all the risks and associates mitigation actions with each of them. It is worth performing a trial installation because it is the first practical application and observation of all the unforeseen turns of event theoretically described in the risk study, and the sooner mitigation actions are implemented, the more efficient and the less expensive it is to correct delays and NCs.

This assessment can be extended with a complete feedback from the practical installation of the blanket occurring at the end of July: since it was proven that the risk evaluation is constrained to subjectivity, experience is the best means to acquire the appropriate knowledge required to assess and mitigate the risk’s impact and probability of occurrence.

References


[8] Daniel Bernoulli, Exposition of a New theory on the measurement of risk, 1738, translated from Latin to English by Dr Louise Sommer.