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Obsolescence Management in Quebec Aerospace Industry

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Abstract

Despite being a significant element of Quebec's industrial economy, employing tens of thousands of personnel, very little is known for certain about the state of obsolescence management in Quebec's aerospace industry amongst academic circles. For the last decade, it has been assumed that the same challenges and shortcomings that apply to the American aerospace industry, which are well documented, apply to Quebec as well. With the Consortium for Research and Innovation in Aerospace in Quebec pushing for the adoption of novel technologies such as electrically powered aircraft, a critical point has been reached where the actual weaknesses and strengths of the aerospace industry in this domain must be assessed in order to prepare for the upcoming transitions. While at the time of writing this report, research is still ongoing, certain interesting information points have already been uncovered. Despite previous assumptions that the industry was handling obsolescence on a reactive basis, in the gas turbine sector, obsolescence is generally managed strategically as a result of product support obligations. More work is yet to be done in order to fully understand the industry landscape, however, these findings are an encouraging sign that the industry is moving towards more sustainable practices.

Keywords
Obsolescence, COTS, FADEC, Aerospace

1.Introduction
While there exists substantial resources regarding best practices, guidelines, and standards for obsolescence management in the aerospace industry, there is a notable void in the literature regarding what the current industry norms are. With the last major study on the matter being released by the American Federal Aviation Administration in 2015, as of 2024, academia does not know what the actual aerospace industry practices are in the field of obsolescence management, nor the degree to which recommended measures have been implemented. Previous reports on the topic have highlighted a worrying lack of capability in the field, with obsolescence being managed on a reactive basis, often at great cost. This "firefighting" approach is not only potentially devastating cost-wise but the delays and challenges associated with obsolescence management failings also significantly damage client-supplier relations and impact the broader supply chain as a whole. There are anecdotal reports that the European aerospace industry has moved to a strategic approach of obsolescence management and that organizations like the Internation Institute for Obsolescence

Management have been pushing for change and transparency in the domain, but this has not been measured in an academic setting and it is unknown if Quebec aerospace companies exhibit the same traits. While the Quebec aerospace industry does not operate on the same scale as its counterpart in the United States, the sector does employ over 40 000 personnel, produces an estimated $15 billion in sales, and serves as the headquarters for the Canadian divisions of global industry leaders such as Airbus, Pratt and Whitney, and Bell Textron. This industry represents one of Quebec's most important assets, and its overall health is critical to the province's overall economic prosperity. With the implementation of potentially disruptive technologies such as electric hybrid engines, composite materials and system on chip (SOC) seemingly just over the horizon, it is more important than ever to understand what the current industry capabilities are to be able to effectively plan for the future and mitigate the risks faced when adopting new technologies with unknown life cycles.

1.1 Objectives

The goals of this study are two-fold. The primary objective is to collect information that will allow for a clearer understanding of the state of obsolescence management in the Quebec aerospace industry. This entails gaining a broad understanding of the practices that are most prevalent in the industry, as well as how obsolescence management is typically integrated into the operating framework of aerospace companies. At the same time, the study attempts to collect further data on where capabilities should optimally be according to industry respondents. Completion of this research will help validate or invalidate prior recommendations on best practices, provide insight into the current drivers of obsolescence issues and provide a baseline for future studies on novel obsolescence management procedures.

2.Literature Review

This research serves as a Quebec-focused follow-up to DOT/FAA/TC-15/33 (Wilkinson 2015), henceforth referred to as TC-15/33. TC-15/33 is a comprehensive report on the capabilities and shortfalls of American general aviation (GA) in the field of obsolescence management, particularly with respect to avionics. The report highlights the difficulties with adequately managing the obsolescence of electronic hardware with the emerging use of commercial off-the-shelf components in GA electronic assemblies. The considerable mismatch between the expected service life of these components in an aerospace application versus the production life of the components for their primary consumers introduces significant uncertainty and risk in the supply chain. This elevated risk, combined with poor communication about components becoming end-of-life (EOL) often leads to GA manufacturers and integrators being caught flat-footed when critical electronic components are discontinued. With the stringent certification requirements present in aviation, failing to implement solutions to obsolescence issues before they materialize can often be a prohibitively expensive oversight because of the costs associated with redesigns and operational delays caused by the need to certify new components.

A useful metric that TC-15/33 presents that is used in this study is the obsolescence management intensity levels. These range from level 0 to level 4, with 0 being no obsolescence management practices in place, and level 4 being obsolescence managed on a broader strategic level. Each level has a set of criteria and practices that must be fulfilled for an operation to be considered as working at that level. According to the TC-15/33, the GA industry generally operates at intensity level 1 or 2, meaning that practices such as bill of materials (BOM) review and obsolescence databases are typically established, but most planning is still reactive and more advanced practices such as electronic data interchanges and alternate source development are not common.

Another useful resource on obsolescence management is the International Electrotechnical Commission's 2019 publication on obsolescence management best practices. Henceforth referred to as IEC 62402-2019(Commission électrotechnique 2019), this document presents standards for best practices for managing A major element pushed by this standard is the risk/criticality assessment. This allows for a distinction between how likely a component will become EOL (risk) and how damaging it would be if the component were to become EOL (criticality). The combination of these two factors is what should be used to inform decisions on whether a part should be pre-emptively replaced, watched closely, or left alone. While this source is not specific to the aerospace industry, many challenges faced by the aerospace industry are not unique to the domain. The use of COTS electronics tends to be a driving factor in obsolescence across the board. TC-15/33 and IEC 62402-2019 generally propose similar improvements to be made to obsolescence management and together serve as useful guidelines for what good obsolescence management should look like.

3. Methods

Given that this research is exploratory in nature, a grounded methodology is the most appropriate way to approach the study. In a grounded approach, data is systematically collected, with theory being generated based on an analysis of the data. This approach aligns well with the overall goals of the research without first having some understanding of the obsolescence management capabilities of the Quebec aerospace industry, typical research methods would yield results that are meaningless as they have no baseline to be compared to. This methodology is also well suited to research in which multiple factors, including human behavior, are at play, as the broader approach allows for more flexibility in determining causal relationships.

For this approach to be successful and for recommendations on most effective practices to be made, a critical element is that of data saturation. A large enough volume of responses must be obtained such that clear trends appear in the data. In practice, this means that virtually every major company, and many small companies should be surveyed in some capacity. This would allow for broader trends that are not particular to a single branch of the industry to be observed.

4. Data Collection

The primary tool used for collecting this data is a multi-part survey (see Annex 1). This survey focuses primarily on qualitative data such as operational capabilities and obsolescence resolution methods. There are equally some quantitative metrics, notably cost breakdowns and obsolescence event occurrence frequency. Part one of the survey (see Figure 1) contains basic questions about the respondent profile. The questions in this section are designed to discern how factors like company size, primary products, and even the job title of the respondent have any impact on the company's obsolescence management capabilities and needs, as well as the individual respondent's understanding of their company's needs and abilities.

Part two (see Figures. 2 & 3) is a self-assessment tool based on the criteria stated in TC-15/33. This allows for a standardized measure to the company's actual obsolescence management abilities. The section will also allow respondents to select capabilities that the company believes it ought to have. In doing this, a clear gap can be established between the needs of the company and its actual abilities. This is important as not all companies' obsolescence management teams need to or should be working at the highest possible intensity level, and so establishing a capability gap is a more meaningful metric then simply comparing current practices to the highest possible level.

Part three (see Figure. 4 & 5) asks for specific examples of obsolescence events and details on how they were handled. This includes information on the cause of the event, the part involved, the cost, and the general timeline of solving the matter. These information points serve several purposes. Firstly, by comparing the capability gap with the stated cost of these obsolescence events, the intent is that a picture will emerge regarding to the general cost of obsolescence management shortfalls in the industry. Determining a general timeline of events in the obsolescence management process will validate that the capabilities listed in the self-assessment tool are working as intended and enabling a more proactive approach to the issue. Finally, given the wide variety of known possible causes for obsolescence, collecting information on the part type and cause will give more insight into what factors actually lead to a higher risk of an obsolescence event occurring.

In order to come to the correct conclusions analyzing the data collected through the survey, information is also being obtained through the use of semi-structured interviews with individuals who work with obsolescence issues on a regular basis. Due to the multi-faceted nature of running an engineering operation and dealing with obsolescence, driving forces in this field are often nuanced and subject to human factors that are not easily discerned through survey data. It is therefore critical to conduct these interviews as a means of attributing the correct causal relationships to trends observed in the collected data.

5. Results and Discussion

Given that this study is ongoing, final and conclusive results have not yet been obtained. With that said, based on preliminary discussions had with personnel from both large and small players in the Quebec aerospace industry, some interesting observations have presented themselves thus far. The following information has been obtained through interviews with various employees of the aerospace industry. As per confidentiality requirements, the identities of the respondents are to remain anonymous.

In general, the aerospace industry is aware of the challenges being faced by obsolescence and are becoming increasingly aware of the need to consider a full product life cycle in the development stage. With that said, while practices like bill-of-material monitoring is commonplace, it is inevitable that components sometimes slip through the cracks. It is simply not viable to monitor every single component on an aircraft, and occasionally companies going bankrupt overnight or global crises will catch even the best prepared teams off guard. When this does happen, someone in the supply chain will see it as a money-making opportunity. While this was briefly touched on in TC-15/33, it appears that the practice is much more common than one would have expected. While not optimal, this approach of letting 3rd parties continue the production of EOL components is extremely flexible and the full extent of this relationship should be looked into further.

Gas turbine manufacturers make up a significant portion of Quebec's aerospace industry output. These companies have mandates that oblige the support of engines for as long as they are in service. This typically represents thousands of hours of runtime over the course of several decades. At the extreme end of the spectrum, one respondent reported an instance in the early 2000's where he was tasked with sourcing a piston head for the engine of a Second World War fighter-bomber. This requirement for full-service life support has effectively forced gas turbine manufacturers to maintain a high proficiency in obsolescence management. Companies generally demonstrate capabilities that would place them as being at intensity level 4, with practices such as dual sourcing, planned system upgrades and road mapping well established and in use. Risk assessment and action plans for at risk components are assessed in a similar way as detailed in IEC 62402-2018. The risk and criticality of components are both analyzed to inform an action plan, and in extreme cases the company may opt to place a strategic lifetime buy for a component, even with the engine being at the beginning of its production run. Another commonly reported practice is that of batch recertification. Certifying an engine for commercial use is extremely expensive process, therefore when there is no other option but to commit to a redesign and recertification, this is taken as an opportunity to update the design so that all other components that are considered high-risk can be replaced at once for the cost of a single certification process.

A common theme mentioned by several respondents was the complications associated with the introduction of full authority digital engine control (FADEC) systems in the late 80's and 90's. Similar to what has been seen with avionics, these electronics opened up a new avenue for obsolescence issues in gas turbine engines. To date, the solution for mitigating this risk has been remarkably simple; high markups. With FADECs being an IP heavy asset with large profit margins, OEMs and first-tier suppliers have enough of an incentive to maintain support for systems that have long since ended production. The relatively low production quantity for engines also enables companies to keep sufficient reserves on hand of at-risk electronic components to prevent supply shortages from materializing when a component is end-of-life.

Data collection systems also tend to be vulnerable to obsolescence, even more so than FADECs. This is a result of these systems being based almost entirely on COTS components and assemblies. While at high risk, the criticality of these components is low, and most data collection equipment is optional and not strictly necessary for engine function. Because of this, developing workarounds tend to be relatively easy.

A smaller sector that has presented some interesting findings so far is the drone industry. The drone business exhibits some unique characteristics that are not shared by the rest of the aerospace industry. Notably, these are the relaxed certification requirements for drones flying over unpopulated areas and the near monopolization of the market by DJI. A common theme expressed by employees of the Quebec drone sector is the constant race to implement new technologies before DJI introduces these technologies to the broader market. In the space of consumer drones, DJI is unrivalled in terms of production volume, allowing them to undercut smaller manufacturers. This reality, combined with lack of certification requirements for drones to be sold to the consumer market, encourages small manufacturers to jump to the newest possible technology as soon as it is available while ceasing production of the models using older technology. This model is inherently resistant to obsolescence issues as components are typically phased out of use before they end production.

Where the Quebec drone sector does demonstrate weakness is in the small batch production specialized drones. Since DJI's focus is on the broader consumer market, which has left small niches for Quebec-based enterprises to fill. The drones that are produced for these niches are often quite technically complex, and design modifications are avoided at all costs as many enterprises do not have the resources to produce and test redesigned models in a way that is sustainable for the business. In this application, as was reported in the American GA industry (Wilkinson), poor communication often leads to enterprises being blindsided by critical component EOL. In all reported instances, the companies were able to source sufficient quantities of the component to meet demand for the projected production run of the drone. This was enabled in large part by the very small quantities required. While the low production quantity means that sufficient quantity is generally expected to be obtainable in the event of part obsolescence, the fact remains that this is never guaranteed, and these sorts of events do typically cause some degree of panic and distress to the affected companies. With a single non-resolvable incident being potentially devastating for the company that uses the part, this is certainly an area where practices can be improved. As it stands, the situation is accurate to what is described in TC-15/33

While the Quebec drone industry is inherently resilient to obsolescence-related issues given the niches that the companies fill, if these enabling factors are lost, the results can be catastrophic. In the consumer space, increased regulation could result in larger number and longer production runs of drones. In this case, obsolescence may begin to be a factor that must be considered for the life of the drone's production. If this were to happen, though, it is very likely that this would be the least of the industry's worries, as being forced to compete in large-scale production against DJI is, by all accounts, a death sentence.

Finally, a concern that was brought up about the general state of obsolescence management was the issue of capability loss caused by retirement the ageing workforce. Many of the people who have been responsible for obsolescence management have been so for decades, and the waves of retirement generated by Covid, and other events have led to a large amount of expertise leaving the workforce at once. New recruits are trained on basic obsolescence management protocols, however, without the understanding of why certain procedures are in place, nor the years of experience of past incidents, their effectiveness is significantly lower. There is a real risk that with the commercial rollout of new technologies like hybrid engines coinciding with the aforementioned retirement waves and loss of experience, companies who may have become complacent and underfunded their obsolescence program while relying on a small number of highly experience individuals will be caught out if issues do arise.

Numerical Results

As this research is ongoing, not enough data has been collected to present any meaningful results. As more fleshed-out responses are obtained over the coming months, this section will be used to outline the number of companies that exhibit each capability listed in TC-15/33, the cost metrics that were stated in the data collection section, and other relevant data that is uncovered.

Graphical Results

Similarly to section 5.1, currently, there is insufficient data collected to display meaningful graphical results.

5.1 Proposed Improvements

At the start of this study, it was assumed that obsolescence management would fall under the umbrella of procurement or possibly engineering. It has since been established that most if not all companies that have a formal obsolescence management team keep that team under the umbrella of Operations Program Management (OPM). Personnel who work in this field are typically few in number and are not as public-facing as other departments. With the extremely siloed nature of many of these enterprises, many personnel within organizations, even as high as the executive level, are not well informed about their own company's obsolescence management practices and many do not even know that it is an element of OPM. This can lead to a significant divergence in responses in answers between someone who is somewhat informed on the company's obsolescence management practices versus someone who is directly responsible for this task. To obtain the most accurate results, this study should and is now making a concerted effort to approach mainly OPM personnel to obtain the most accurate results possible.

6. Conclusion

While this research is far from complete, initial probing into the practices of obsolescence management in Quebec's aerospace industry paint a picture of a more robust and adept than one may be led to believe going off of literature alone. While heavy siloing and loss of experienced personnel to retirement may have damaged the overall capability of the industry in this field, the major players have now had decades of experience in managing obsolescence and have largely adapted to the challenges posed by the introduction of electronic systems and components. Without more information, however, it is still impossible to determine if the industry is sufficiently prepared for the new technologies that are coming down the pipeline.

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Biographies

Dr. Yvan Beauregard has over 30 years of industry experience having worked at companies such as Pratt and Whitney Canada and IBM and over a decade in academia as a lecturer at Montreal's Concordia University and full professor at École de Technologie Supérieure from the University of Quebec. Yvan is a leading expert in lean engineering and has also been contributing to obsolescence management.

William Grant is a final-year mechanical engineering undergraduate student studying at the University of McGill in Montreal. His interest in sustainable development and big-picture thinking has led him to take on this project to gain a better understanding of some of the challenges faced by our aerospace industry.

Annex 1

This section has been added to include a copy of the survey which has been presented to the participants of this study. The self-assessment criteria in Figure 2 have been adapted from TC-15/33 (Wilkinson 2015), with the intensity levels intentionally omitted to prevent bias in the responses.

Section 1a: Company Information			
Company Name:			
Primary Product/Business:			
Which of these best describes your organization/company?	Please Select One		
Approx. how many personnel does your organization/company employ?			
Section 1b: Point(s) of condact for Survey Completion			
Name:	Job Title:	Phone Number:	Email Address:
Date Of Completion			
Comments:			
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Figure 1. Survey section 1.

Section 2: Capability Self-Assessment		
Capability	Capable/ Desired	Provide example of implementation or opportunity for improvement where applicable. If your company has a capability that is similar but not exactly the same as that listed, select "C" and elaborate here.
No OM (obsolescence management) program established. Incidents are dealt with ad hoc.	C ☐ D ☐	
OM program established and funded	C ☐ D ☐	
DMT hired and trained in OM fundamentals.	C ☐ D ☐	
OM plan written and approved	C ☐ D ☐	
Complete BOM developed for all products with periodic reviews planned to keep it current.	C ☐ D ☐	
Solutions to near-term obsolescence problems implemented.	C ☐ D ☐	
OM tasking and data inserted in the development, production or support contracts of new acquisitions	C ☐ D ☐	
BOM processing through a predictive tool and results analyzed to identify high risk components.	C ☐ D ☐	
OM solution database established.	C ☐ D ☐	
OM website established.	C ☐ D ☐	
Method Established to prioritize LRUs for OM risk.	C ☐ D ☐	
OM life-cycle costs and cost avoidance estimates developed.	C ☐ D ☐	
DMT trained in OM essentials and advanced OM.	C ☐ D ☐	
Funding shortfall and impact identified and communicated to decision makers.	C ☐ D ☐	
OM metrics established (number of cases, number of solutions implemented, life-cycle costs and cost avoidance, etc.)	C ☐ D ☐	
OM tasking and data requirements included in applicable contracts for legacy systems.	C ☐ D ☐	
Electronic data interchange implemented and in use between manufacturers for efficient exchange of obsolescence data.	C ☐ D ☐	
Technology road-mapping used.	C ☐ D ☐	
System upgrades planned.	C ☐ D ☐	
Technology transparency attained.	C ☐ D ☐	
Accesilibilty realized for alternate source development.	C ☐ D ☐	
If your organization has implemented any OM capabilities which are not listed in the section above, please specify what they are in the section below.		
In your opinion what are the most urgent needs that would bridge the gap between current and desired OM practices? Please identify the top 3 priorities in the short term from your perspective? (for example defining required processes and metrics, developping and offering training, improving capability to address uncertainty related to obsolescence and DMSMS events, etc.)		
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Figure 2. Survey Section 2

Relevant Definitions			
Acronyms	OM	Obsolescence Management	The practice of mitigating the negative consequences associated with an in-use product being declared obsolescent or end-of-life.
	NHA	Next Higher Assembly	The larger overall assembly in which the part in question is a component.
	LRU	Line Replaceable Unit	Modular component designed to be quickly replaceable on-site by the operator.
	BOM	Bill Of Materials	A list of all components in an assembly.
	DMSMS	Decreasing Material Supply & Material Shortage	Interchangeable term for obsolescence
	DMT	DMSMS Management Team	Officially sanctioned team created with the goal of handling obsolescence events.

Figure 3. Survey section 2 definitions.

Section 3a: Obsolescence Event 1					
Explain the issue for which a solution was developed and if possible specify root cause (technological development, new regulation, etc.).					
Part Type	Select One	Specify the commodity of the part & whether mechanical, electric, electronic or digital.		(e.g. cockpit electronics)	
Solution Type	Please Select One	If other, please specify			
If soltution developped resolved multiple obsolescence issues (eg. NHA redesign replacing 2 discontinued processor chips) specify how many total issues were resolved					
Estimated Total Cost Of implementing Solution					
Please Break Down this Total By Category Below					
Engineering Cost		Implementation Cost		Certification Cost	
Please Provide the General Timeline of Events that Best Describes the Development Process of this Solution					
Select One	Select One	Select One	Select One		
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Figure 4. Survey Section 3

Relevant Definitions		
Solution Types	Approved Part	Obsolescence issue is resolved by the use of items already approved on the drawing and still in production.
	Life of Need Buy	A sufficient quantity of the item is purchased to sustain the product until its next technological refresh or discontinuance of host assembly.
	Repair, Refurbishment or Reclammation	Obsolescence issue is resolved by instituting a repair or refurbishment program for the existing item or assembly.
	Extension of Production or Support	The supplier is incentivized to continue providing the obsolete items.
	Simple Substitute	The item is replaced with an existing item that meets all requirements without modification to either the item or its NHA and requires only minimal qualification.
	Complex Substitute	A replacement item that has different specifications, but requires no midification of the source product or the NHA. Is researched and validated.
	Development of a New Item or Source	A replacement product is developed that meets the requirements of the original product without affecting the NHA. The new product may be an emulation, a reverse-engineered product or a product developed as a replacement using a different manufacturer but the original manufacturing designs and processes.
	Redesign - NHA	The affected item's NHA must be modified. Only the NHA is affected, and the new design will not affect anything at a higher level in the system.
	Redesign - Complex/System Replacement	A major assembly redesign affects assemblies beyond the obsolete item's NHA and may require that higher-level assemblies, software, and interfaces be changed.
Part Type	Assembly	Any grouping of parts that result in a final unit that is considered a distinct item. Examples: network switch, gas turbine engine, starter motor.
	Component	A base unit part that maay be used as part of an assembly. Example: a piston, an electrical switch, an integrated circuit.
	Raw Material	The substance or substances out of which a thing is or can be made. Example: Steel, teflon, fiber glass.
	Software	The programs or other code used by computers of other electronic components or assemblies. Example: An operating system, anti-virus software, development environment
Commodity		In this context, a commodity refers to the general element of the aircraft's function that the part contributes to. Examples include: navigation system, cockpit, auxiliary power unit, wings, fuel system, etc.
Costs	Engineering Costs	The one-time cost of research, design and engineering work related to the solution selected. This also includes qualification, software development, tooling and other costs.
	Implementation Costs	The administrative costs associated with implementing the selected solution, such as retrainig, creation of new technical manuals, retrofitting of existing devices and updating records.
	Certification Costs	The costs associated with certifying modified components with aviation governing bodies. This includes the cost associated with lost time.
Electrical		Equipment that generates electricity, transfers or controls electricity, or which uses electricity as its prime energy source (excluding electronics). Example: motors, transformer, switchboard.
Electronic		Components, assemblies, or equipment that are built using electronic components and/or circuit card boards. Example: computers, radios, radars, control circuitry.
Mechanical		Parts, assemblies, or equipment that is neither electronic or electrical in nature. Example: deisel engine, pumps, hydraulics.
Digital		Assets or intellectual property that are code-based and exist within a software ecosystem. Example: Source codes, information databases.

Figure 5. Survey section 3 definitions.

Part 4: Final Comments
Thank you for taking the time to answer this survey. Your responses will go a long way to helping us better understand industry needs. If you have questions regarding the general nature of obsolescence management and industry best practices, feel free to reach out to us. If you believe that this survey missed any information that may be of value to this study, feel free to mention it in the comment bar below.
The International Institute of Obsolescence Management (IIOM) is an organization dedicated to improving the knowledge and best practices in the domain of obsolescence management. The organization has branches in several countries including the UK and France. Do you think it would be beneficial to your enterprise to participate in the creation of a canadian chapter of the IIOM and do you think this is something your enterprise would be interested in doing?
Your knowledge is invaluable to us. If you would like to further assist us in performing this research, and would be interested in engaging in a brief inverview to provide us with your individual insight, please let us know. Thank you.
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Figure 6. Survey section 4.