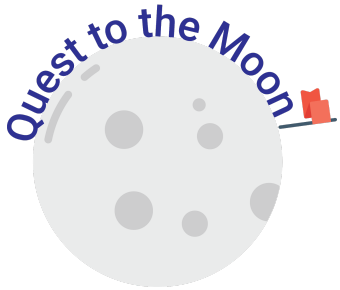
Achieving *Astronomical* Gains in Information Flow



Anusha Dixit, Alexander Leipold, Neehar Peri,

Uday Warier & Emma Wilkins

QUEST HONORS PROGRAM

NORTHROP GRUMMAN

UNIVERSITY OF MARYLAND 18 56

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Letter From the Team

QUEST to the Moon!
1407 Van Munching Hall University of Maryland
College Park, MD 20742

May 14, 2020

Mr. Daniel J. Nice
Northrop Grumman Corporation
55 Thiokol Rd, Elkton, MD 21921

Dear Mr. Nice,

Our team would like to take an opportunity to thank you for giving us the opportunity to work with Northrop Grumman Corporation in identifying areas for improvement in information flow throughout the Elkton site. Your efforts in helping connect us with the right information, stakeholders, and resources were instrumental in helping us craft our recommendations, receive feedback, and iterate upon our ideas.

We would also like to thank the 23 different stakeholders from each of the 15 different stakeholder groups, including manufacturing engineers, testing engineers, project engineers, program managers, technical writers, schedulers, and technicians, that provided our team with valuable insights and feedback to ensure that our recommendations are widely accepted and alleviate relevant bottlenecks in information flow.

The following report details the scope of our project, methodology, recommendations, and projected impact. Throughout our project we have taken a stakeholder-first approach, listening to the needs of the customer and designing solutions that address the root cause of potential problems. Our team is confident that these recommendations can help save Northrop Grumman time, money and resources by alleviating potential bottlenecks in information flow. Most importantly, our recommendations provide a set of tools to facilitate continuous improvement to ensure that our recommendations can evolve as the needs of Northrop Grumman change.

It was a pleasure working with you and members of the Elkton plant at large. We hope that we have provided a framework to deliver value and improve process efficiency and information flow at Northrop Grumman.

Sincerely,

Anusha Dixit
Alexander Leipold
Neehar Peri
Uday Warier
Emma Wilkins

Executive Summary

The development of rocket motors and similarly advanced technologies requires efficiency in information flow in order to meet deadlines on time and within budget. Northrop Grumman is aiming to streamline information flow between stakeholders and minimize existing bottlenecks in the process.

In order to assess the current state of information flow at the Elkton, MD site, the team conducted interviews with stakeholders both onsite and virtually. Using insights gained from these interviews, the team identified several pain points in the current project lifecycle, from some stakeholders being unable to offer input or access project-specific information in a timely fashion to a lack of knowledge transfer between valuable stakeholders.

The team developed three primary recommendations to streamline information flow from its current state. The first is to ensure that all relevant stakeholders attend project kickoff meetings, regardless of when they may enter the project lifecycle, and subsequently document the kickoff meetings in a uniform manner for later reference. The second recommendation involves the dynamic documentation of roles and responsibilities as they changed throughout the project lifecycle in a RACI matrix. The final recommendation is to compile existing knowledge of manufacturing processes in a text- and video-based knowledge management system (KMS), in order to ensure the transfer of knowledge.

The three-phase implementation process starts with an initial pilot KMS on the company's SharePoint system in order to begin gathering stored information, and execution of the optimized kickoff meetings and role documentation. During the second phase, volunteers will be able to record process videos and start adding information to the KMS. As expanded over the next year, the KMS will accrue substantial information in order for stakeholders to begin referencing it when needed, and the kickoff meetings and responsibilities documentation will be optimized to best suit accompanying projects.

These recommendations can be expected to substantially improve information flow upon implementation through saved time and resources. With the complete implementation of the recommendations, the team expects to bring in $615,000 in annual savings to Northrop Grumman. In both streamlining information flow and accruing substantial savings, the proposed recommendations are assuredly beneficial.

I. Problem Statement and Opportunities

Northrop Grumman is a global aerospace and defense technology company based in the United States. With approximately $30 billion in annual revenue, it is one of the largest manufacturers of weapons and military technology in the world. In 2018 Northrop Grumman gained an additional manufacturing site in Elkton, through an acquisition of Orbital ATK, another leading aerospace and defense technologies company. Now part of Northrop Grumman's Defense Systems Group, the Elkton site produces rocket motors for space launch and military applications.

With hundreds of buildings and employees, the Elkton site receives dozens of contracts in any given year. These projects introduce complex processes that increase the risk for information flow bottlenecks to occur. We were challenged to address information flow across manufacturing processes to identify areas for improvements.

When visiting the plant and talking to stakeholders, we realized that improving communication would be the focal point of our recommendations. Throughout a contract, there are several areas in which clear stakeholder communication is critical for moving a project through its lifecycle. Through interviews with various stakeholder groups, we discovered several pain points in which communication breaks down. These stakeholders each voiced their concerns about information flow across the plant and recommended solutions that would help make their roles smoother. We listened to this feedback and identified several root causes of information bottlenecks: key stakeholders are not involved during the planning phase of a project, dynamic team member responsibilities and personnel changes cause confusion, and key information is not being organized appropriately.

II. Methodology

Given an initially open-ended scope, our first approach to scoping out opportunities for improvement was to gather as much data as possible on current information flow bottlenecks occurring at Northrop Grumman through stakeholder interviews. This is what we did at our first site visit, where we conducted fourteen interviews with nine different stakeholder groups and talked to various different employees about some of the challenges they faced on a daily basis. The first site visit was treated mainly as an information-gathering exercise, so we gained a great deal of feedback from stakeholder interviews that translated into a lot of potential avenues to explore. The main opportunities for improvement we got out of the first site visit are summarized in Appendix A.

From there, the next order of business for us was to narrow down our set of potential opportunities to those that were most important and those that most directly affected the challenges outlined in our scope. To do this, we came up with a ranking scheme for each of the

opportunities for improvement to figure out how each one related to all the others. The tool we used to rank each problem as well as the rankings we ended up with are included in Appendix B. We scored each opportunity for improvement in terms of impact and feasibility; impact encapsulated how much each opportunity for improvement affected information flow and how likely it was to cause information flow bottlenecks, and feasibility encapsulated how realistic a solution proposed by us would be to implement. As is apparent in the plot, the subset of improvement areas we decided to focus on for the remainder of our project are the ones highlighted in green, as those opportunities most directly impacted information flow while also remaining the most feasible in the selection.

It is important to note here that all of the information we used to rank opportunities came directly from our stakeholder interviews. If stakeholders told us a certain problem had a very high impact and affected information flow to a great extent, we ranked that problem very highly on the impact scale. In this sense, all the ideas and recommendations we eventually came up with are not our ideas—they are ideas that already exist within the ranks of Northrop Grumman, and we are simply bringing them to light.

This employee-centric perspective continued in our methodology after we managed to narrow down our scope and were brainstorming recommendations. We not only had to identify solutions to Northrop Grumman's problems, but we also had to make sure that these solutions would actually be implemented by the employees. We recognized that our recommendations would require a large cultural shift at Northrop, and to ensure adoption we had to make sure to consider the end users of our recommendations as primary stakeholders in the process. In practice, we underwent many stages of refinement for each recommendation. We developed three surveys to get our recommendations in front of a wider range of employees, we created wireframes and templates of our recommendations to gather feedback from employees, and we even piloted some of our recommendations with employees to see how our recommendations fit in with the rest of their process. Overall, our methodology was to continuously improve our recommendations, to ensure a seamless transition into Northrop Grumman's overall process.

III. Recommendations

A. Short-Term Recommendations

The final recommendations we are implementing will benefit stakeholders both in the short-term and long-term. The short-term recommendations will provide instantaneous benefits upon implementation, while the long-term recommendations will provide increasing benefits with time.

The first short-term recommendation involves adding some structure to project kickoff meetings. Currently, not all relevant stakeholders attend project kickoff meetings,

primarily because their roles intersect with the project at a later stage. This prevents them from providing essential input at the inception of a project that may impact their contributions later in the project lifecycle, thus reducing efficiency and/or accuracy in task completion. Our recommendation serves to first and foremost include all relevant stakeholders at every kickoff meeting, regardless of when they enter the project life-cycle. By doing so, all relevant stakeholders are kept in the loop, so any additions or changes that may need to be made earlier in the project can be incorporated with ease. For example, a testing engineer kept in the loop for a project from the beginning can look over a design and ensure that the proper mechanisms needed for testing a product are in place in the design phase instead of having to add such a mechanism later in the process, which results in significant delays. In addition, kickoff meetings will be documented with greater uniformity to allow for more convenient referencing later in the process. If each kickoff meeting follows a concise, lean template (Appendix C), any employee who is unable to attend or otherwise searching for the information provided at the meeting will be able to more conveniently access essential points and responsibilities, as opposed to personally contacting involved parties to glean necessary information.

The second short-term recommendation addresses the dynamic documentation of roles and responsibilities. Employee roles tend to change during a project lifecycle; they may take on more tasks than previously anticipated, and these additions often go undocumented. If another stakeholder wishes to refer back to a certain task that was completed during a previous project, and the employee responsible for the task was never officially documented, they may wind up spending a great deal of time zig-zagging between employees trying to track down who completed the task. In addition, personnel changes may result in an employee spending half of their work day catching up on the current status of the project, which is time better spent making tangible contributions. In order to streamline this dynamic information access, the team recommends the implementation of a RACI matrix (Appendix D) at an employee level. Though this matrix is already in use at the managerial level, enabling employees to document the tasks that they complete will capture dynamic changes in a project. The implementation of RACI matrices for use by all stakeholders ensures that everyone can keep their responsibilities updated for future reference.

B. Long Term Recommendation

Our third recommendation is aimed at the long-term for Northop Grumman. In our interviews with stakeholders, we discovered the prior implementation of videos to capture manufacturing knowledge in several areas of the plant. When we asked why these videos were abandoned, many of the stakeholders stated that they were unsure, and that they thought the videos were effective at the time. This started the team on the idea that

capturing knowledge across the plant in a similar format would enable stakeholders to retain crucial information. While reforming our hypotheses, we wanted to avoid the pitfalls of past video implementation. A structured KMS, with an ability to search through videos and sort by different criteria, was identified as the solution. For our second round of interviews, we asked stakeholders what aspects of a new system were important to them. From these interviews we discerned that rather than simply a video KMS, a text-based system should be implemented as well to cover the needs of different stakeholders. This text-based system would enable employees to ask questions in a plant-wide forum and provide answers to be utilized for future projects. The separation of the KMS system into two separate components therefore appeals to the needs of different stakeholders, while staying true to the end-goal of retaining the crucial knowledge of employees at the Elkton site. When forming our concept of what the end system would look like, we developed wireframes of key components to show employees (Appendix E). Receiving several points of feedback through interviews and surveys, we sketched a final version of the KMS to propose to leadership. The final wireframe designs contain home pages and search features, the ability to upload and modify, and components that give end users the resources they need to take information out of the systems.

In order to gauge how our recommendations will fit into stakeholders' daily experiences, we constructed three surveys. Based on the survey results, 70% of respondents believe that kickoff meetings would generate "a great deal of value", and 60% agreed that the current role definition was only somewhat effective (Appendix G-I).

IV. Risk and Mitigation Strategies

We realize that not everything outlined in our implementation plan may go as smoothly as we foresee. Therefore, we considered the risks associated with our recommendations and what we have done to mitigate them. Much like our ranking system for the original word cloud of problems, we outlined the three main risks associated with our recommendations and ranked them on a likelihood vs. severity scale (Appendix F) before describing mitigation.

The first risk we identified is the possibility that what we are recommending may disrupt Northrop Grumman's current process flow instead of improving it. This risk had a very high severity associated with it because disrupting the current process flow is exactly the opposite of the purpose of the project. However, we gave this risk a relatively low likelihood, and the reason for this goes hand-in-hand with our mitigation strategy, which was to make our recommendations as lean as possible. For the short-term recommendations, we provided template documents and presented the meeting agenda template and RACI documentation as tools rather than process changes to ensure our recommendations would be as lean and non-disruptive as possible. For the long-term recommendation, optimizing the KMS for ease of

usage, modification, and searchability was our way of making that system as user-friendly as possible so as to minimize training time.

The second risk we identified is that our recommendations, specifically the KMS, could encounter scalability issues and fail to generalize to all stakeholders at the Elkton site. We ranked this risk at medium severity, since in this case only a portion of the stakeholders would use our recommendations in the long-term, which still constitutes an overall win as compared to the previous process. We also viewed this as medium likelihood of occurrence, due to our mitigation strategy. In our implementation plan, we propose a six-month pilot of the KMS with project engineers, manufacturing engineers, and program managers to see what works and what doesn't before the full system is rolled out to everybody in the plant. The reason for this pilot group is that these are the specific stakeholder groups that sparked the idea for this recommendation, so we are confident that they will be able to derive a lot of value from a system like this. We understand that a six-month pilot for any new system is common at Northrop Grumman, so the idea is that after the six month period is over, insights from the pilot group will serve as building blocks upon which to roll out the KMS to all stakeholders in the plant, thereby mitigating the risk that the KMS encounters scalability issues.

The final main risk we identified is that our recommendations may lack widespread adoption. While we ranked this low in severity, this is the highest likelihood risk since widespread adoption is one of the most difficult things to achieve when employees are already used to set procedures. What we are mainly doing to mitigate this risk goes back to our methodology: by constantly improving and refining our recommendations based on stakeholder feedback, the end products reach a state where they are most likely to be accepted by all stakeholders.

V. Impact

Given this risk mitigation strategy, the team will bring approximately $615,000 in annual savings to Northrop Grumman. To estimate the financial impact of the proposed recommendations, the team built a five-year cost/benefit forecast model (Appendix K).

The analysis includes the variable and fixed costs of the KMS, as well as the incremental benefits of the three recommendations. For the KMS recommendation, the benefits follow three categories: productivity gains, proactivity gains, and gains in root cause evaluation. The benefits of the kickoff meetings and improved roles recommendations stem from productivity gains and proactivity gains. The model was created with conservative assumptions in order to provide a realistic estimate. Through meetings with the team's project champion, key inputs for the model were determined. All of the benefits of the recommendations relate to efficiency gains, or time saved in the process. Therefore, benefits were determined by estimating how many hours could

be saved from each recommendation and attributing the appropriate group exempt rate (Appendix J).

A. KMS Benefits

The KMS contributes the most to the average annual benefit of the recommendations, making up 70% of the total. This recommendation also incurs the highest costs, primarily because it requires fixed development costs that the short-term recommendations do not. The KMS begins with a six-month pilot, during which it only applies to the manufacturing engineering, project engineering, and program management groups, representing a total of 84 stakeholders. The team assumed that benefits would begin to accumulate after three months of this pilot. Productivity gains are estimated to arise as 25% of the stakeholders upload an entry at least once a month, and 10% of users refer to the KMS to retrieve knowledge. The model assumes that five hours are saved per average use – incremental time that was previously spent searching for the relevant knowledge – and a half hour is added per average use – the amount of additional time it takes a stakeholder to input and retrieve knowledge. With these assumptions, the team projects $32,850 in productivity gains from the KMS in year one. Proactivity gains take the form of an average percentage savings of the monthly nonconformance rate. Through team discussions with the project champion, the percentage saving was predicted to be 10%, the average monthly nonconformance rate to be $750, and the average number of monthly non conformances to be 110. Proactivity gains in year one are $57,750. Finally, gains in root cause evaluation are calculated by estimating that the KMS can save four hours per evaluation (from more efficient documentation), and that seven root cause evaluations occur in an average month. The gains in root cause evaluation are projected to be $35,280 for year one.

B. Kickoff Meetings Benefits

For the kickoff meetings recommendation, the team represented productivity gains by determining that on average seven new team projects are launched every month across the plant. Thereafter, the assumption was made that every team project that begins with a kickoff meeting will result in five hours of saved time. With an average ten-person sized team, this translates to a half hour of saved time per team member because the kickoff meeting clearly sets project expectations and thus reduces information asymmetry later in the process. With benefits appearing in month three of implementation, year one productivity gains reach $75,600. The proactivity gains for this recommendation emerge through the following reasoning: with kickoff meetings in place, expectations and objectives will be streamlined, ultimately resulting in the successful completion of projects in less time. After discussion with the project champion, the team settled on a

5% savings in labor costs, determined by the average number of monthly new team projects, the average team size, and the engineering exempt rate. Proactivity gains for year one amount to $6,300.

C. Roles and Responsibilities Benefits

Finally, the roles and responsibilities recommendation portrays productivity gains as the time saved that is traditionally spent by stakeholders performing tasks outside of the scope of their positions. To arrive at this estimate, the average team size and number of monthly team projects is required, as well as the projection that one hour is saved per team member per project. With this calculation, productivity gains reach $126,000 in year one. Proactivity gains relate to the time saved that is traditionally spent rearranging roles and responsibilities in the event of a personnel change during a project. Historical data indicates an average of twenty programs per year, with two personnel changes per program. The assumption is that five hours are saved in rearranging roles and onboarding the stakeholder to the project through the features of the recommendation. The proactivity gains for year one make up $1,800.

D. Fixed Costs

The fixed costs for the implementation of the KMS can be grouped into employee training, software development and maintenance, and other expenses. First, the employee training category takes into account the development of the training resources and the cost of the training sessions. Based on similar past initiatives, the training resource development is estimated to take 40 hours, leading to costs of $7,200. For the cost of training sessions, the hourly engineering rate is applied to the number of stakeholders being trained per month. Thus, the total cost of training sessions, which are spread across the first two years, is $84,240. Second, the software development and maintenance category reflects the costs of building the KMS and keeping it current. The lessons learned repository initiative required approximately 200 hours of development, and the team assumed 250 hours for the KMS to reflect the added video-based functionality, leading to $45,000 of development costs. Software maintenance was estimated to cost $63,000 per year, which is the engineering average across other tools. Third, the other expenses category consists of the costs of purchasing body cameras and updating command media. The team recommends 28 cameras in order to equip each building across the site. With a purchase price of $315, including the body strap attachment (estimate provided by site videographer), the total cost of cameras amounts to $8,820. Furthermore, the command media update is projected to require 80 hours, based on previous projects, and thus costs $14,400.

The financial impact of the recommendations increases for most of the five year forecast period, with projections of approximately $185,000 in year one, $550,000 in year two, $700,000 in year three, and $820,000 in years four and five. This increase aligns with the proposed modular rollout of the recommendations to different stakeholder groups, as well as an estimated increase from five to ten hours in team savings for the kickoff meetings recommendation and a higher exempt rate in year three for the KMS productivity gains. A shortcoming of the model is that its structure currently does not take into account period of performance due to the wide range of project types and length of engagements. The team recommends a further analysis into the effect that period of performance would have on efficiency savings. Additionally, it is important to keep in mind that the financial benefits of the model stem from saved time, which leads to the underlying assumption that the recommendations do not adversely affect productivity in other process areas. The team is confident in this assumption due to the lean design of recommendations, which even have the potential to improve productivity downstream.

VI. Implementation & Next Steps

In order to improve information flow at the Elkton plant and reduce bottlenecks, our team has recommended the introduction of structured kickoff meetings to ensure that all stakeholders share a common understanding of the task at hand, documented roles and responsibilities through a RACI matrix, and a KMS that can help capture key decision points and lessons learned in a lean, cost-effective manner. We propose a three phase plan to adopt these recommendations at Northrop Grumman.

A. Phase One

First, we recommend creating a temporary SharePoint site to contain the KMS either in-house, or through contracted software engineers who will implement a design with similar feature specifications as described in our wireframes. This temporary SharePoint site will initially contain our templates for kickoff meetings and RACI matrix documentation. In this stage, we anticipate the engineers at Northrop Grumman will adopt our templates to better suit the needs of teams. Each template serves as a guide, and should be modified on a per-project basis. However, the key components that we outline, particularly involving all stakeholders involved in a project, will persist in all project kickoff templates. We anticipate this first phase of implementation will take approximately two months.

B. Phase Two

Next, we recommend expanding the text-based KMS to a larger number of users. We recommend piloting the system with manufacturing engineers, project engineers, and

program managers. We selected this group of 84 people specifically because many of their job functions already require that they create documentation for part requests, client requests, and project modifications. Having these stakeholders tailor existing documentation for the text-based KMS will require minimal additional effort. While piloting the text-based system, we recommend purchasing a small number of action cameras to help facilitate the video-based KMS. Our final proposal calls for 28 total video cameras, so we recommend first piloting the system with five action cameras. The video pilot should launch with a small group of volunteers to record test videos and provide feedback on the benefits and drawbacks of the system. We recommend conducting surveys to find strategies that help minimize the amount of active processing time. These videos and surveys can help introduce new users to the KMS. We anticipate that the pilot of the text-based KMS will take 6 months.

C. Phase Three

Lastly, we recommend expanding the KMS across the plant. We have identified 468 total stakeholders that can benefit from the KMS. We anticipate that full roll out of the KMS will take one year after completing the pilot.

We anticipate that our proposed KMS will have the greatest impact on improving information flow at the Elkton plant. In order to see the full benefit of our proposed system we need strong adoption from all stakeholders. In order to increase adoption, we recommend migrating relevant data within the command media to the new KMS. This new system should primarily be used to capture highly referenced documentation and data that may change during the duration of a project. This will help increase the number of touch-points with the proposed system, leading to increased use.

VII. Results

With a modular implementation plan and risk mitigation strategies in place, the team is confident that the KMS, kickoff meetings, and roles and responsibilities recommendations can meet the projected financial impact. The methodology of interviewing and surveying a diversity of stakeholders was influential in helping to determine the areas in information flow with the highest potential for improvement and embrace for change.

In the ideal state, every team project begins with a kickoff meeting and the creation of a RACI matrix to document member roles. Thus, immediately from the start of a project all stakeholders are on the same page. Traditionally, due to Northrop Grumman's complex manufacturing processes, teams may encounter disruptions or process confusion early on in the project, which results in delays due to alignment meetings or the uncoordinated search for knowledge. With the team's recommendations, these delays are potentially avoided, as expectations are made clear

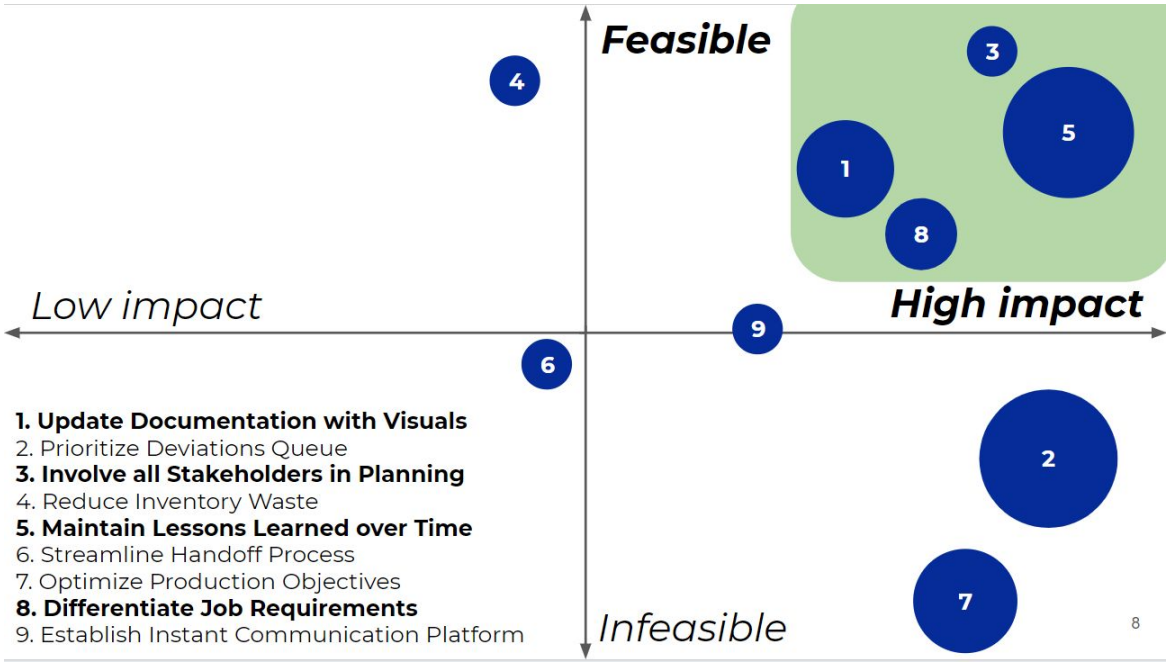
from the start. If a deviation still occurs, the KMS provides a convenient reference point to react promptly. Furthermore, later on in the project a personnel change could occur. Traditionally, the employee onboarding and training process could be costly and lead to bottlenecks in the team project. With the dynamic documentation of roles and responsibilities, training time is drastically reduced. At the end of the day, these delays are avoided through the recommendations, which allows for more effective and efficient project completion.

In the near term, the team envisions a state in which the KMS is a treasure trove of knowledge—a portfolio of sorts that captures key takeaways and best practices—with standard kickoff meetings and well-defined team member roles encouraging consultation of this system. Ultimately, however, this is only the beginning. The KMS opens the door to future innovations, ranging from VR capabilities for onboarding to predictive analysis for preventing the recurrence of deviations from previous projects. The team is confident that through the KMS, coupled with support from all inclusive kickoff meetings and clearly defined team roles, long-term impact in information flow can be achieved.

Appendices

Appendix A: Word cloud of opportunities for improvement from first site visit

Appendix B: Plot that was used to rank opportunities for improvement



Appendix C: Kickoff Meeting Template

Customer Requirements

Production Scale: E units of product F with respect to building capacity G

Minimum Design Requirements: Must withstand impulse H within volume J using material K

Minimum Process Requirements: Must use L process within machine M

Minimum Testing Requirements: Must pass at least testing benchmark N

Stakeholder Responsibilities

Writers: Create documentation up to standard

Project Engineers: Create product design, satisfy mission-critical requirements

Manufacturing Engineers: Create process design within process requirement parameters

Tooling Engineers: Source materials based on material requirements

Technicians: Manufacture products within design and process requirements

Testing Engineers: Work with stakeholders to ensure product is ready for testing

Project Timeline

- **May 2020:** Project Start
- **July 2020:** Documentation Deadline
- **November 2020:** Product Design Deadline
- **January 2021:** Process Design Deadline
- **March 2021:** Material Sourcing Deadline
- **July 2021:** Manufacturing Deadline
- **May 2021:** Project End

Recap and Questions

Contact SMEs for specific questions down the line, redirect general questions to Lead PM

Project A Kickoff

Date: May 7, 2020

Time: 9:00 AM EST

Location: Conference Room B

Participants

Lead Program Manager, General Question POC: John Smith

Writers: Julia Smith (SME), Joe Smith

Project Engineers: Jane Smith (SME), Justin Smith, Juliette Smith

Manufacturing Engineers: Josh Smith, Jim Smith (SME), Jen Smith

Tooling Engineers: Julianna Smith, Jacob Smith (SME), Jasmine Smith

Technicians: Jessica Smith, Joy Smith (SME), Jean Smith, Jackson Smith

Testing Engineers: Joel Smith, Josie Smith (SME)

Configuration Management POC: Jack Smith

Quality Engineering POC: Justine Smith

Scheduling POC: Jerome Smith

Agenda

1. **Contract Information**
2. **Customer Requirements**
3. **Stakeholder Responsibilities**
4. **Project Timeline**
5. **Recap and Questions**

Contract Information

Contract Issued by: Company C

Contract Size: $D

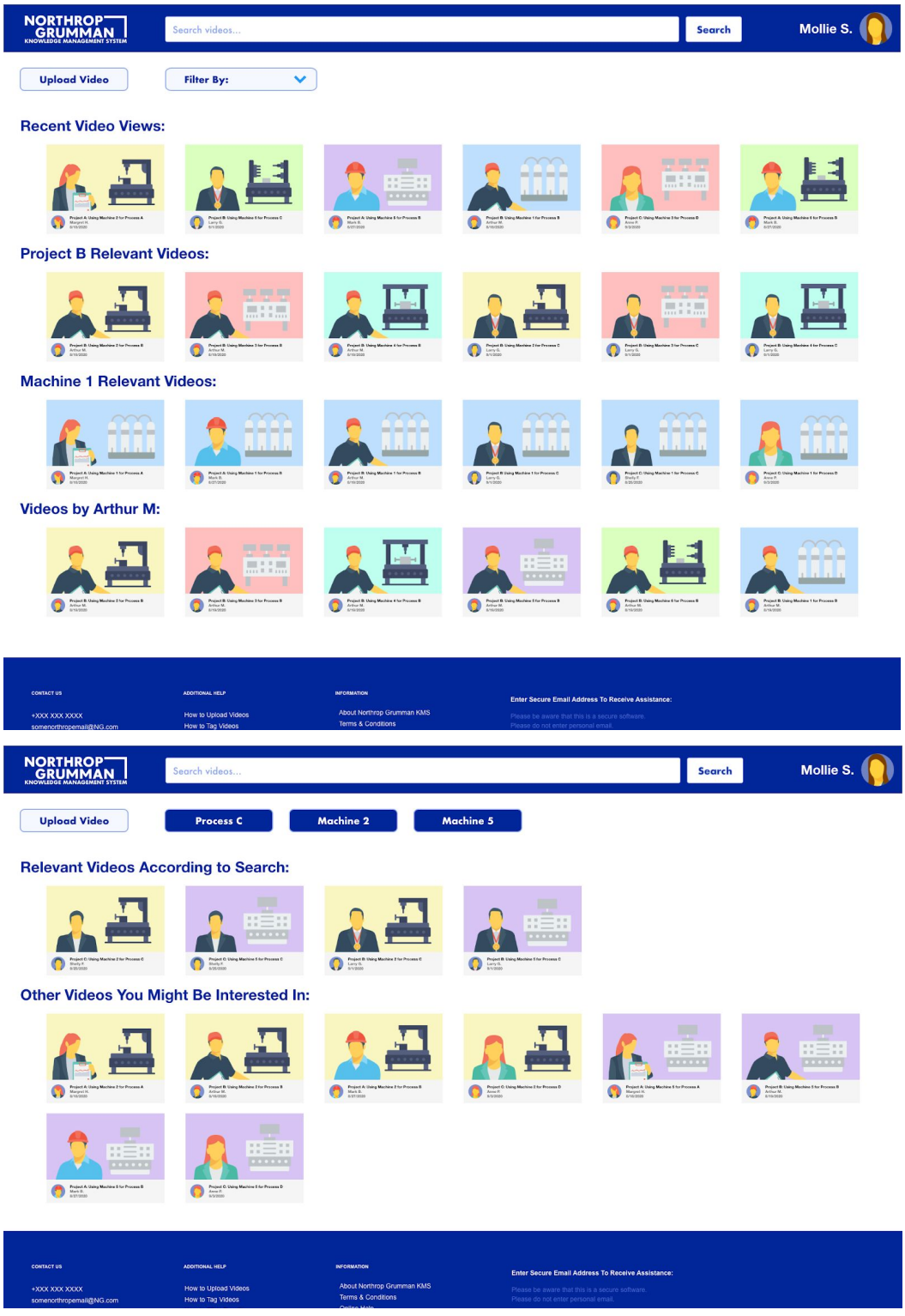
Contract Deadline: May 7, 2021

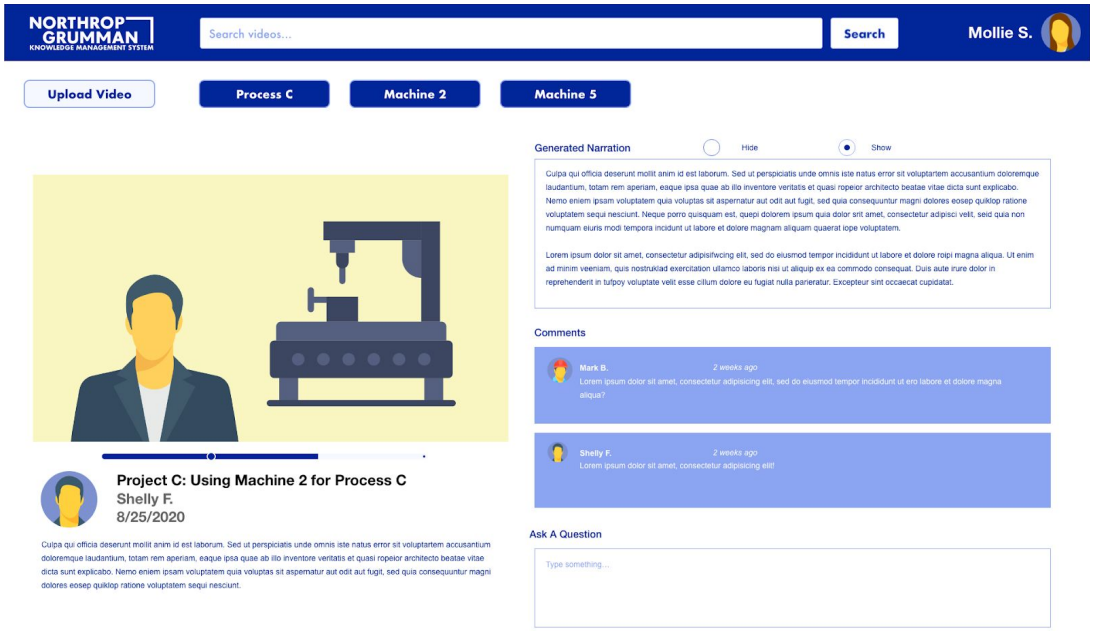
Appendix D: RACI Matrix Template

	Project Manager	Project Engineer	Configuration Management	Tooling Engineers	Quality Engineers
Finalize customer requirements	R	A			
Communicate with customer to improve requirements	I	R			
Product Design Trades		R			
Quality Requirements Determination	I	C	I		R
Tooling Design Trades	I	C		R	
Preliminary Design Review	R	A	I	A	A
Product Specification Documents	A	R	I	C	C
Design Analysis	A	C			R
Incorporation of improvements from analysis	A	R	I		I
Tooling Design Iteration	A	C		R	
Tooling Design Process Finalized	A	I		R	
Final Model Finalized	A	A		C	C
Process Paperwork Release	R	C	C		
Model/Drawing Release	R	C	C		

Appendix E: Wireframes

Video-Based KMS Wireframe




NORTHROP GRUMMAN
KNOWLEDGE MANAGEMENT SYSTEM
Search videos...
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Shelly F.
2 weeks ago
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Project C: Using Machine 2 for Process C
Shelly F.
8/25/2020
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Ask A Question
Type something...
CONTACT US
+XXX XXX XXXX
somenorthropemail@NG.com
Office 347 Bldg. 5
ADDITIONAL HELP
How to Upload Videos
How to Tag Videos
How to Filter Results
FAQ
INFORMATION
About Northrop Grumman KMS
Terms & Conditions
Online Help
Enter Secure Email Address To Receive Assistance:
Please be aware that this is a secure software.
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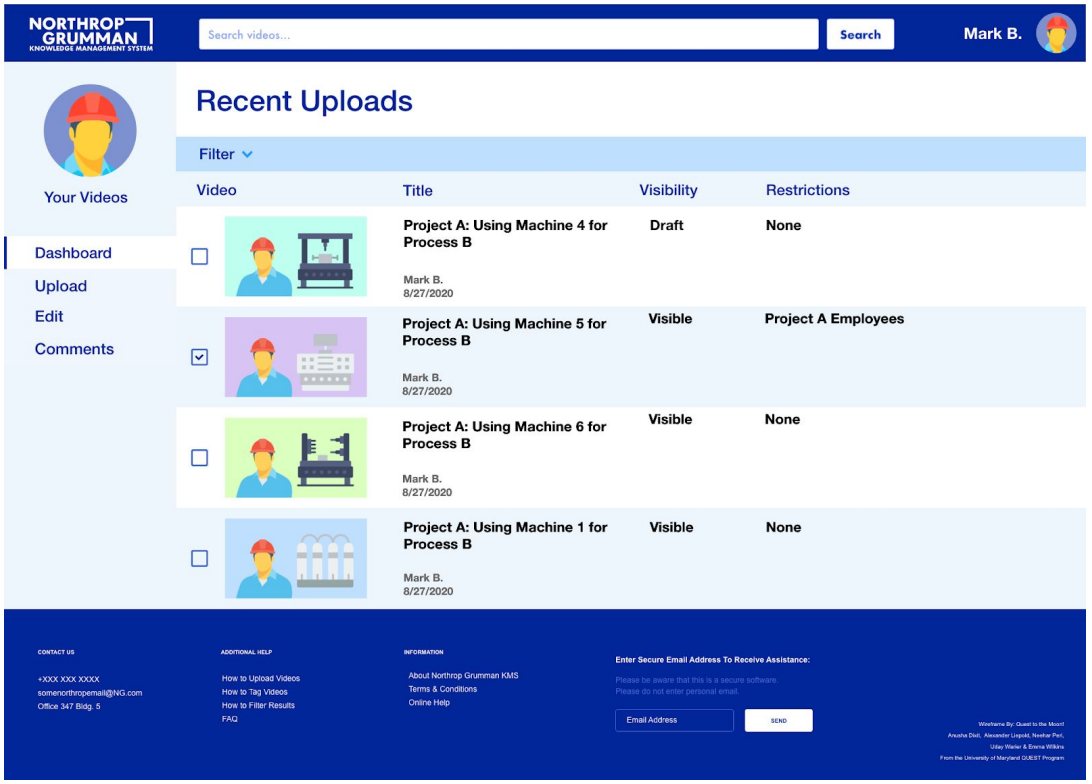
Wireframe By: Quest to the Moon!
Anusha Dixit, Alexander Liepold, Neehar Peri,
Uday Warler & Emma Wilkins
From the University of Maryland QUEST Program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KNOWLEDGE MANAGEMENT SYSTEM
Search videos...
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Project A: Using Machine 4 for Process B
Mark B.
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None
Project A: Using Machine 5 for Process B
Mark B.
8/27/2020
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Project A Employees
Project A: Using Machine 6 for Process B
Mark B.
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Project A: Using Machine 1 for Process B
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somenorthropemail@NG.com
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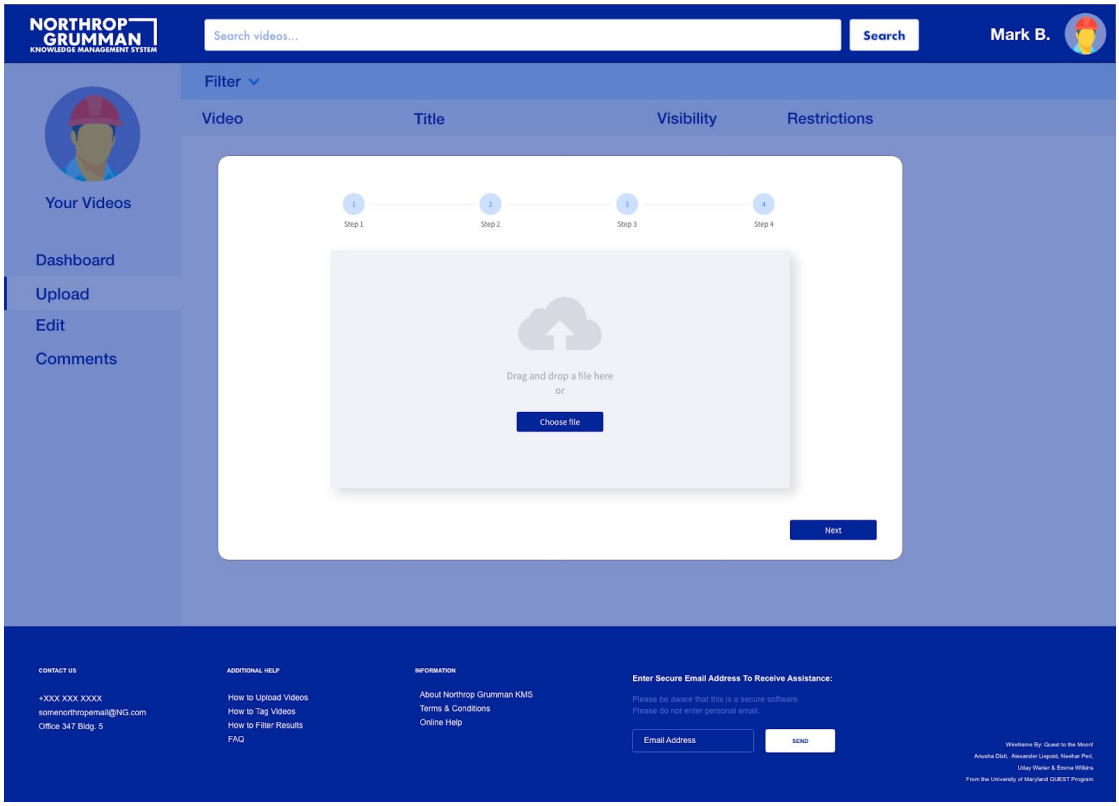
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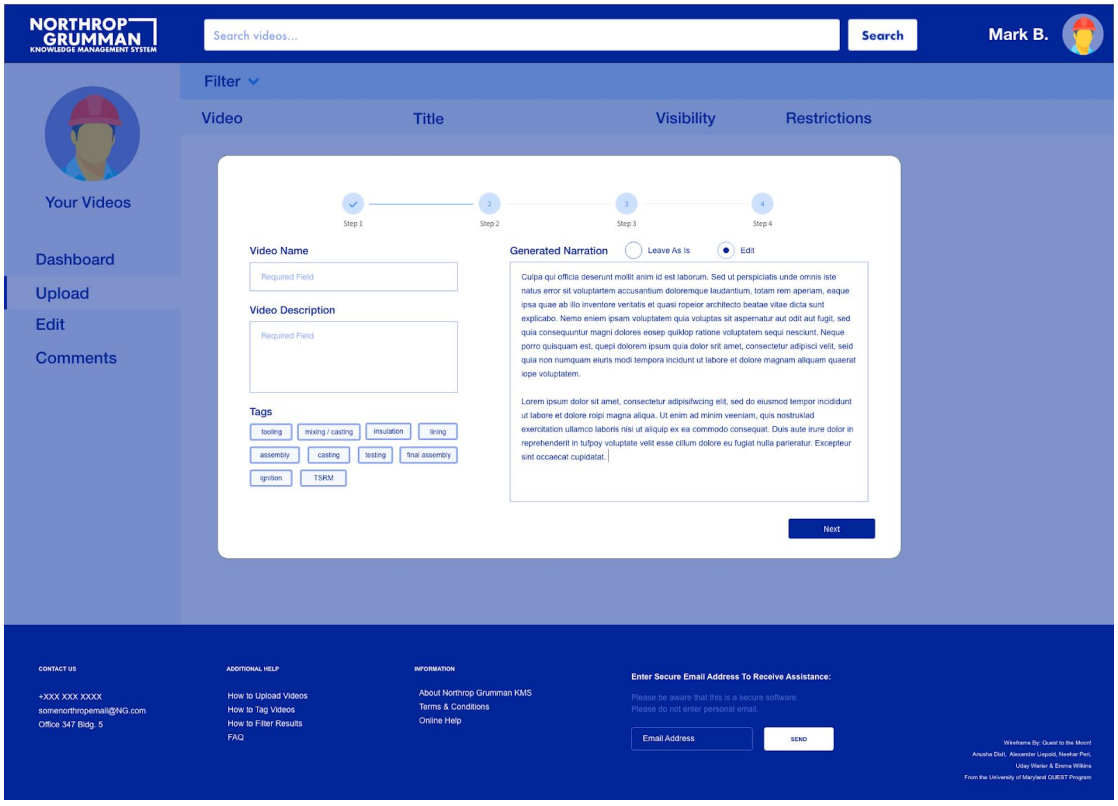
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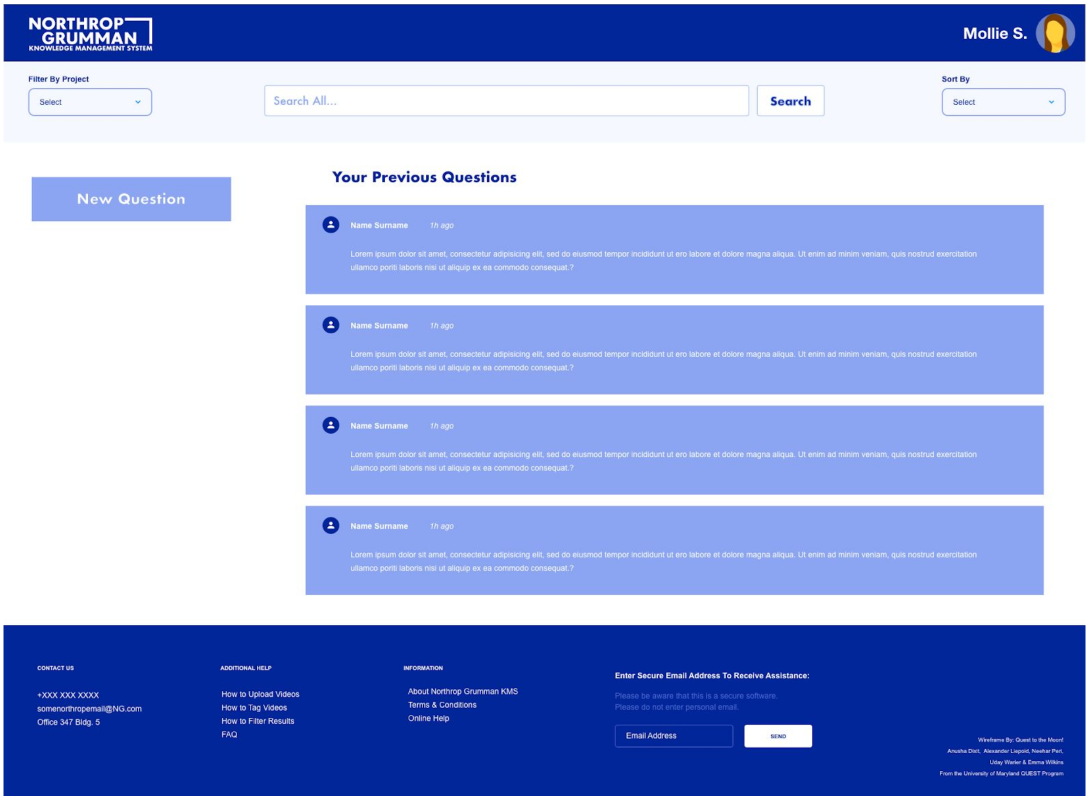
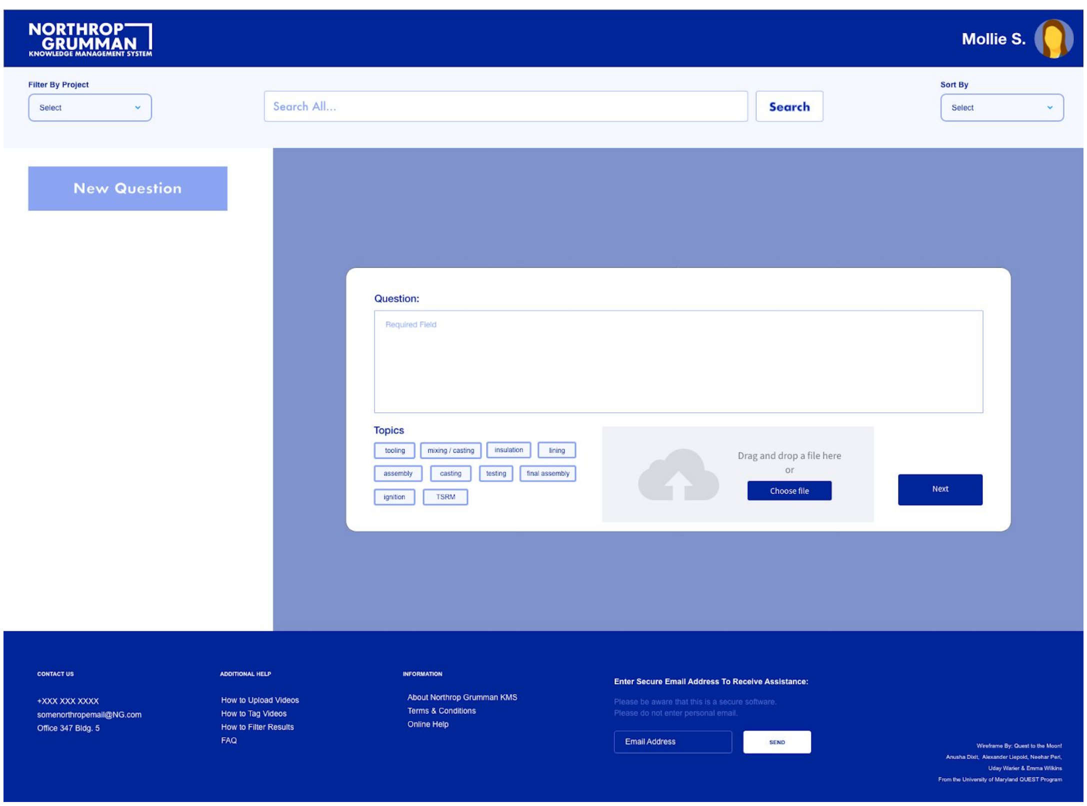
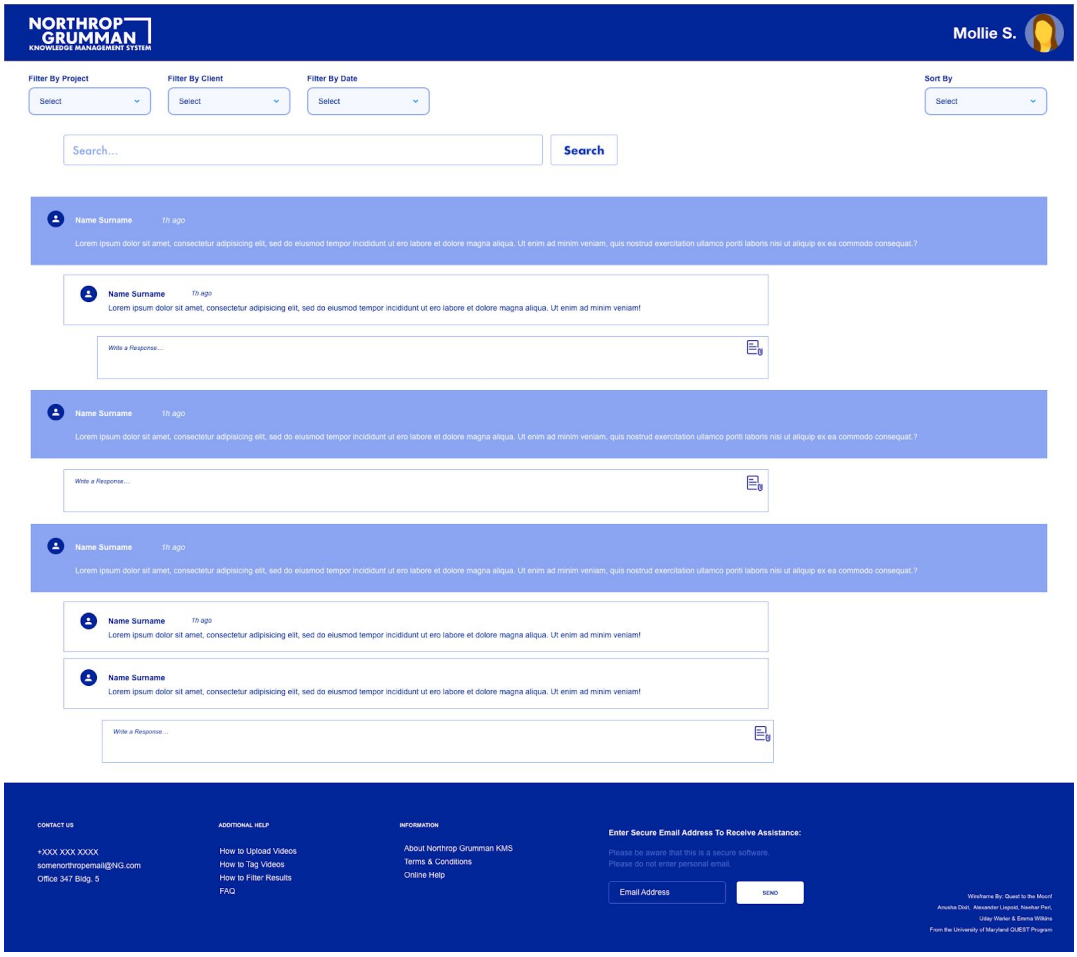
Text-Based KMS Wireframe



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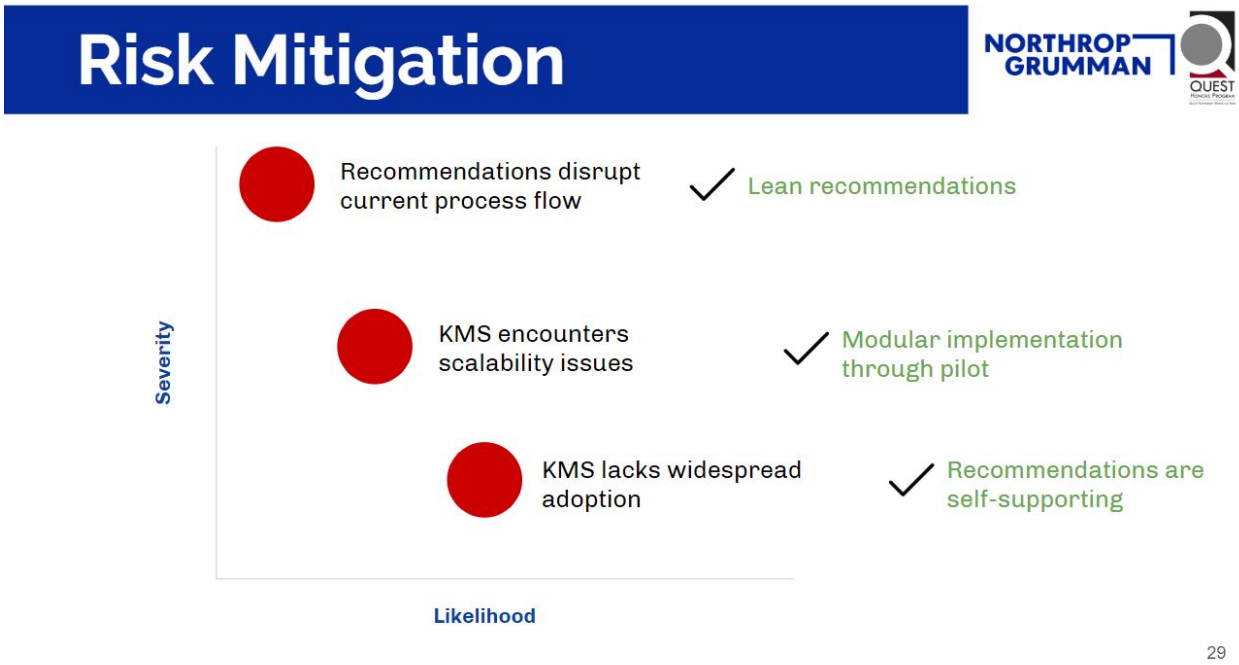
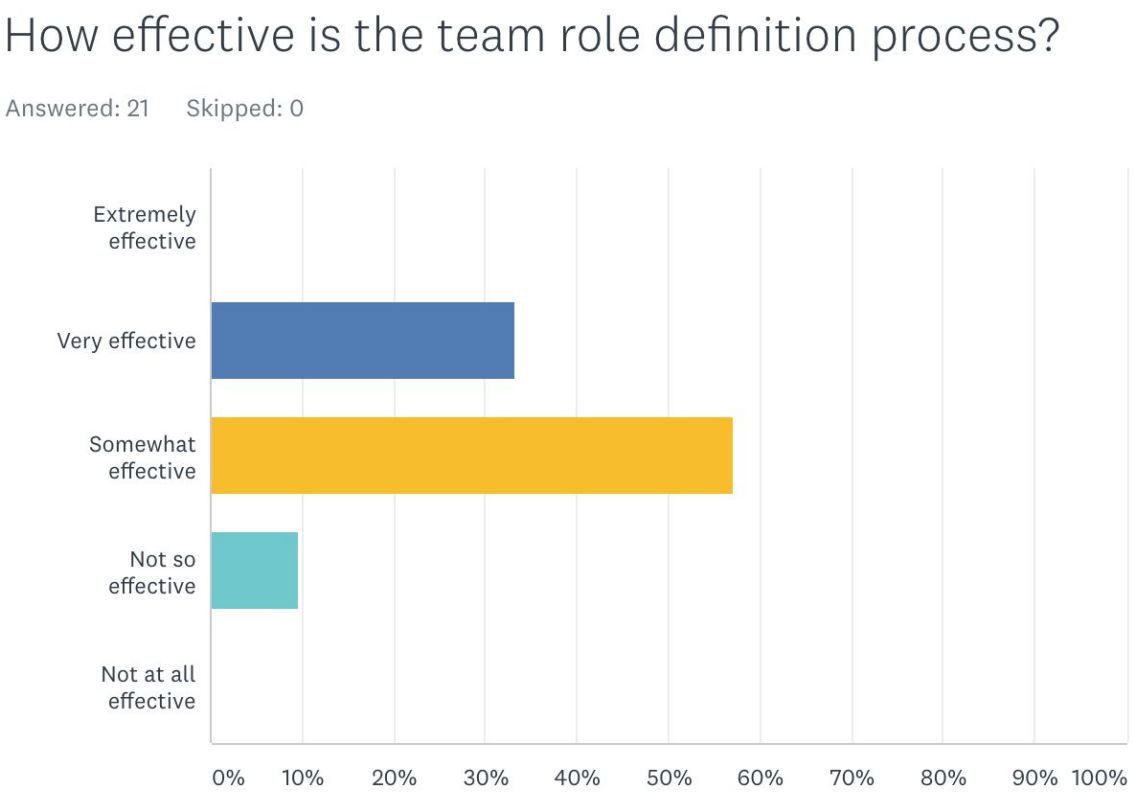
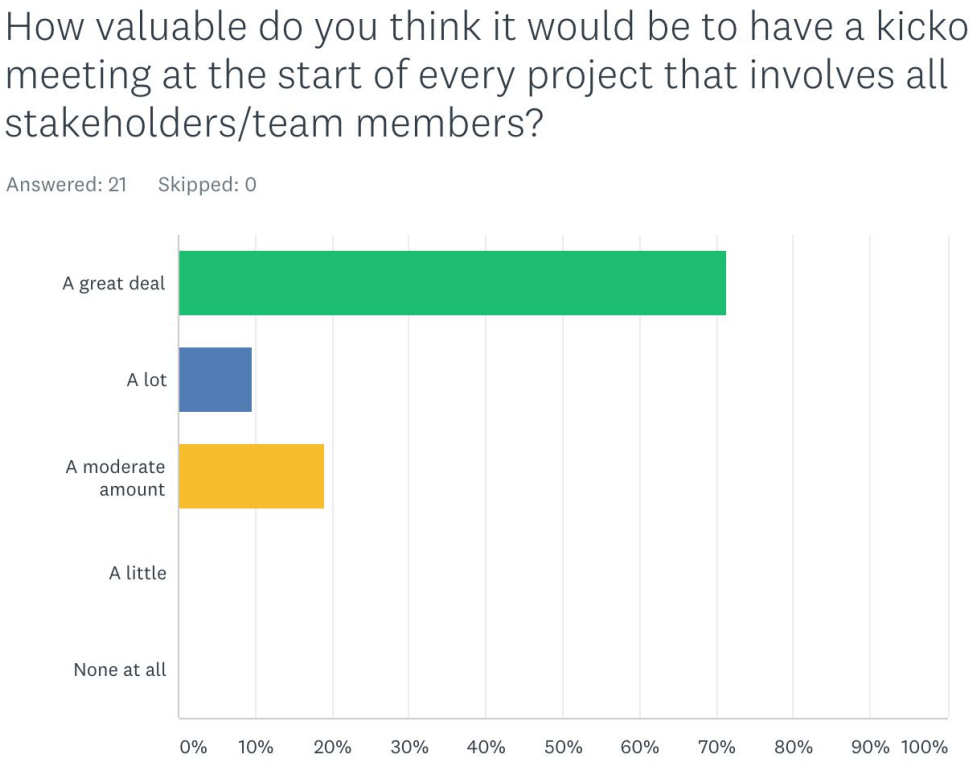
Appendix F: Plot of severity/likelihood of risks and mitigation strategies



Appendix G: Plot of response distribution from survey to assess roles & responsibility recommendation potential



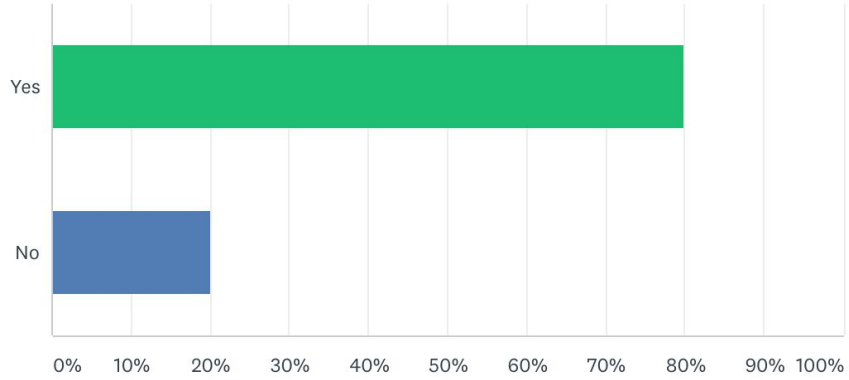
Appendix H: Plot of response distribution from survey to assess kickoff meeting recommendation potential



Appendix I: Plots of response distribution from survey to assess knowledge of and interaction with lessons learned repository

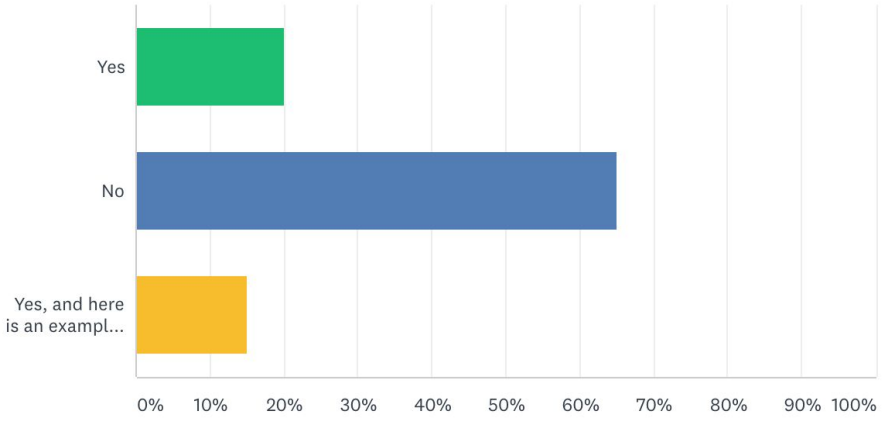
Are you aware of the current text-based repository that stores process documentation, procedures, and insights from previous programs?

Answered: 20 Skipped: 0



Do you regularly use this lessons learned repository when creating, writing, reviewing and/or approving new process documentation, procedures, and insights?

Answered: 20 Skipped: 0



Appendix J: Average rates and number of employees in each group

Note that primarily the engineering rate was incorporated in the model (to reflect conservative inputs)

Group	Exempt Rate
Engineering Rates	180
PM Rates	180
Manufacturing & QC	215
Group	**Non-Exempt Rate**
Engineering Rates	110
PM Rates	90
Manufacturing & QC	120

Group (Highlighted = Pilot)	Employees
Manufacturing Engineering	29
Project Engineering	35
Program Management	20
Design Engineering	6
Systems Engineering	11
Design/Drafting	14
CM	9
Analysis Engineering	22
Research and Materials Engineering	17
Avionics Engineering	9
Quality Engineering	24
Non-Destructive Test	9
Inspection	35
Tooling Engineering	11
Process Document (writer)	6
Ops Technicians	65
Machine Shop	22
Facilities Engineering	6
Facilities/Maintenance Tech	27
Material PM	12
Logistics	9
Planning	13
Scheduling	7
Safety	7
Security	5
Proposals	10
Program Finance/Analyst	14
Accounting	6
HR	2
Contracts	9
Total	**471**

	Assumptions	Y1	Y2	Y3	Y4	Y5
Benefit						
KMS		168,630	656,280	752,880	871,560	871,560
Kickoff Meetings		81,900	158,760	158,760	158,760	158,760
Improved Roles & Responsibilities		127,800	153,000	153,000	153,000	153,000
TOTAL BENEFITS		378,330	968,040	1,064,640	1,183,320	1,183,320
Cost per Usage						
Editing of Knowledge (Input)		21375	150930	150930	150930	150930
Reviewing of Knowledge (Retrieval)		21375	150930	150930	150930	150930
TOTAL COST		42750	301860	301860	301860	301860
GROSS BENEFIT		$ 335,580.00	$ 666,180.00	$ 762,780.00	$ 881,460.00	$ 881,460.00
Fixed Expenses						
Employee Training		*38,160*	*46,080*	-	-	-
Training Resource Development	One-time					
Training Sessions	Length of session is	$38,160.00	$46,080.00			
Software Development and Maintenance		*108,000*	*63,000*	*63,000*	*63,000*	*63,000*
Building KMS	One-time expense i	$45,000.00				
Maintenance	Average across en	63,000	63,000	63,000	63,000	63,000
Other Expenses		*5,040.00*	*3,780.00*	-	-	-
Data Storage	Still needs input					
Cameras	28 buildings using	5,040.00	3,780.00	-	-	
Command Media Update	80					
TOTAL FIXED EXPENSES		151,200.00	112,860.00	63,000.00	63,000.00	63,000.00
NET BENEFIT		$ 184,380.00	$ 553,320.00	$ 699,780.00	$ 818,460.00	$ 818,460.00