Data Management System for the Department of Mathematical Sciences

Design, Implementation, and Future Enhancements

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Introduction

The Mathematical Sciences Department (D/Math) at the United States Military Academy (USMA) is both a consumer and producer of large amounts of data. Prior to this effort, D/Math faced significant challenges in managing that data. Documents and data were scattered across disparate locations and often difficult to locate. The data were not linked over time, making it challenging to piece together a complete picture of D/Math's activities. In addition, most data sources were free text with minimal validation, and many daily operations relied on inefficient back-and-forth email exchanges.

To address these issues, I designed an SQL database to centralize and structure the data, a Power App to facilitate accurate input and validation, and Power Automate flows to streamline notifications and approval processes.

Objectives

The goal of this project was to design and implement a comprehensive data management system that would address the department's operational and administrative needs. Specifically, the system was required to centralize the storage of data, enforce structure and validation standards, and enable the automatic integration of information from USMA's authoritative sources. Additionally, it needed to ensure the protection of data against unauthorized access or modification, establish connections among data originating from multiple operations, and enhance the overall efficiency of business processes.

System Overview

The system integrates three core components: the SQL database, the Math App, and automated processes that connect both to internal and external systems (Figure 1). The database is organized into four primary domains—faculty, cadets, projects, and funding—providing a structured foundation for departmental data. Every morning at 0500, information on faculty, cadets, and courses is automatically imported from the Academy Management System (AMS), ensuring that departmental records remain aligned with academy-level data.

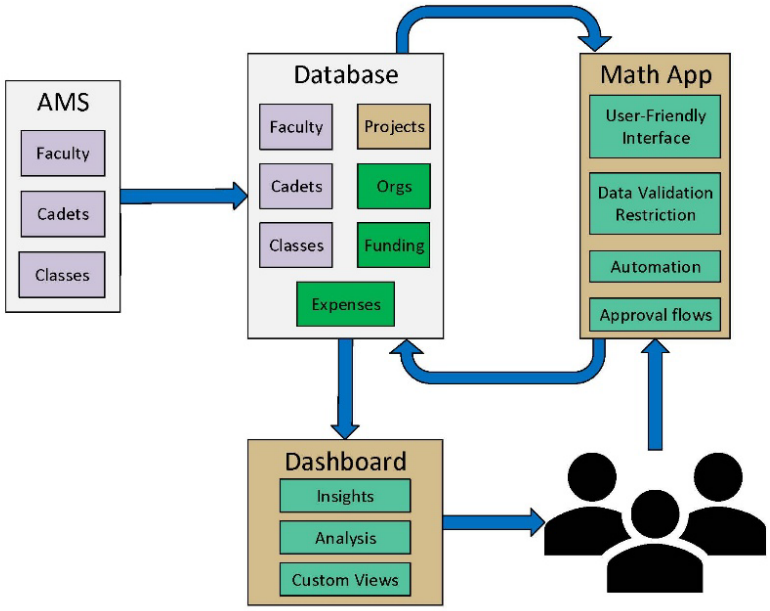

Figure 1: Overview of integrated systems

Users interact with the database exclusively through the Math App, which serves as the controlled entry point for new or supplemental information not maintained in AMS. The application enforces data validation, applies role-based permissions, and enables faculty and staff to contribute updates relevant to their roles. For example, faculty may establish research projects and associate them with cadets, advisors, sponsors, and publications, while administrative staff can record funding transactions and expenditures.

Although not depicted in Figure 1, Power Automate flows extend the system's functionality by generating approval processes and producing standardized PDF memoranda. These workflows reduce reliance on email, streamline departmental procedures, and maintain consistent documentation within SharePoint. Together, the database, app, and automation form an integrated system that enhances both the accuracy and efficiency of departmental operations.

System Architecture and Design

The database supporting this system consists of 84 tables, 41 views—five of which are dedicated to Power BI—and four stored procedures. A complete diagram of the database schema is provided in Figure 2, Appendix A).

Most tables are populated through user interactions with the Math App, which serves as the primary interface for data entry and management. The automatic AMS connection updates designated columns in eight key tables: personnel, faculty, classes, class offerings, sections, cadets, majors list, and cadets' majors. Other tables, such as those supporting lookup values or specialized departmental processes, are currently maintained manually through SQL Server Management Studio (SSMS) by members of the department's research staff. Table 1, Appendix A provides a complete listing of these tables, their update schedules, and priorities to enhance their update mechanisms. A list of stored views and procedures and their uses can be found in Table 2, Appendix A.

Additional resources, including instructional materials for the Math App, source code for SSMS, and PowerApps code, are provided in Appendix B. Together, these elements form the technical foundation of the system, enabling secure, validated, and efficient data management across the department.

Impact

The system significantly improves the department's efficiency, accuracy, and oversight. Automated imports from AMS eliminates redundant entry and keeps departmental data consistent with academy records. The Math App reinforces data integrity through structured input, validation, and role-based permissions, allowing users to contribute information while safeguarding sensitive fields. Power Automate further streamlines workflows by replacing lengthy email exchanges with structured approval processes, automated notifications, and organized document storage in SharePoint. Together, these tools reduce delays, improve accountability, and ensure reliable recordkeeping. Beyond daily operations, the system also provides strategic value. By linking faculty, cadets, projects, sponsors, and funding in a single platform, the department gains a comprehensive view of its activities, enabling better reporting, assessment, and long-term planning.

Future Enhancements

Although the system has addressed many of the department's data management challenges, several areas remain for improvement. At present, certain data—such as lookup tables, leave and pass records, additional and departmental duties, and AIADs—still require manual entry through SSMS. Incorporating these inputs into the Math App would be the most immediate and impactful enhancement, further reducing reliance on direct database interaction. Once this functionality is in place, the system could be extended through the development of Power BI dashboards. These dashboards would enable rapid analysis and a more holistic view of departmental activities, supporting both day-to-day oversight and long-term strategic planning. Additional enhancements might include expanding the system to track departmental property, moving AIAD management from simple recordkeeping to full planning support, and broadening the range of data integrated from AMS. Ultimately, the system has the capacity to accommodate a wider set of departmental processes, further strengthening its role as a comprehensive management tool.

Conclusion

The development of this system marked a significant step forward in how D/Math manages its data and daily operations. What was once a fragmented collection of unstructured documents and email-based processes has been transformed into a unified, validated, and automated platform. By centralizing information in a SQL database, enabling structured interaction through the Math App, and streamlining approvals with Power Automate, the department now benefits from greater efficiency, consistency, and transparency in its academic and research activities.

Equally important, the system provides a foundation for continued growth. With planned enhancements such as Power BI dashboards, expanded AMS integration, and broader process coverage, the platform is positioned to evolve into a comprehensive tool for managing not only data, but also the strategic direction of the department. In this way, the project not only addressed

immediate operational needs but also laid the groundwork for sustained improvement and long-term institutional impact.

Acknowledgements

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- **COL James Starling:** Provided the impetus for the project and discussed it at length with me, giving me a vision for what the system could become.
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- **Mark Aldridge:** Created the Azure account and database, enabling the project to move forward.
- **Mike VanCleave:** Assisted extensively with Power Apps and Power Automate, spending significant time adjusting connections and managing licensing issues.
- **Clint Sikes:** Assisted with SSMS code and wrote the script that connects the D/Math database to AMS.
- **LTC Jon Paynter:** Recognized the system's importance and emphasized its adoption within the department.

Acknowledgement of Assistance

ChatGPT. Assistance given to the author, AI. I asked ChatGPT to give me feedback on parts of the report I had written. It provided me recommended changes to make the report flow better and maintain consistent tone and style throughout. OpenAI, (https://chat.openai.com/). Chester, VA, 20AUG2025.

Appendix A

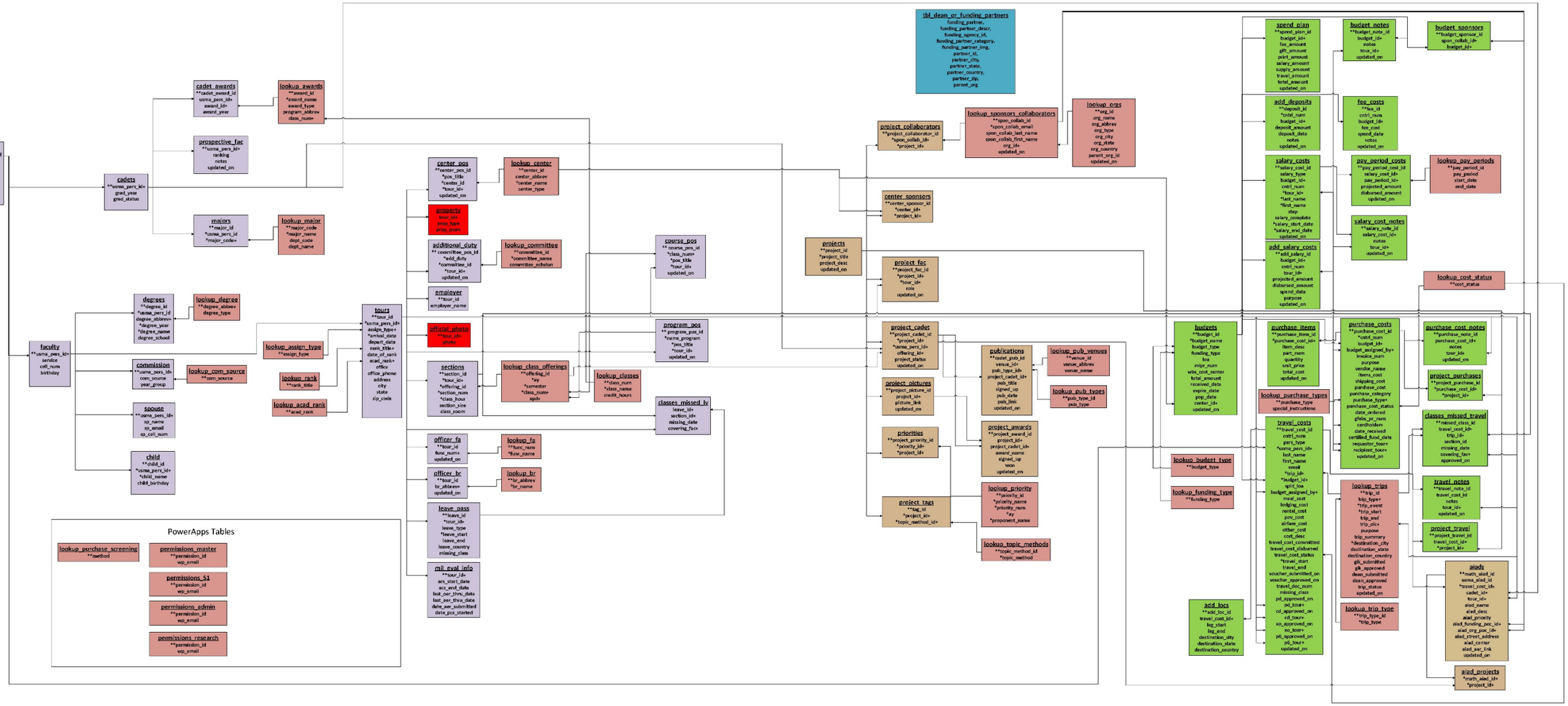

Figure 2: Detailed diagram of database tables

Table 1: SSMS update schedule and priority

	Name	Type	Update Mode	Responsibility	Frequency	Priority to Enhance
1	personnel	Data Table	Automatic	ODA AMS connector	Every day at 0500	N/A
			App	Individual	Upon arrival/change	
2	faculty	Data Table	App	Individual	Upon arrival/change	N/A
3	lookup_com_source	Lookup Table	SSMS	Research Team	Rarely	L
4	commission	Data Table	App	Individual	Upon arrival/change	N/A
5	spouse	Data Table	App	Individual	Upon arrival/change	N/A
6	child	Data Table	App	Individual	Upon arrival/change	N/A
7	lookup_degree	Lookup Table	SSMS	Research Team	Rarely	L
8	degrees	Data Table	App	Individual	Upon arrival/change	N/A
9	lookup_assign_type	Lookup Table	SSMS	Research Team	Rarely	L
10	lookup_rank	Lookup Table	SSMS	Research Team	Rarely	L
11	lookup_acad_rank	Lookup Table	SSMS	Research Team	Rarely	L
12	tours	Data Table	App	Individual	Upon arrival/change	N/A
				Individual/S1	Upon departure	
13	program_pos	Data Table	App	S1/APDs/PDs	Prior to AY	N/A
14	lookup_classes	Lookup Table	Automatic	ODA AMS connector	Every day at 0500	N/A
15	lookup_class_offerings	Lookup Table	Automatic	ODA AMS connector	Every day at 0500	N/A
			App	S1/APDs/PDs	Prior to semester	
16	sections	Data Table	Automatic	ODA AMS connector	Every day at 0500	N/A
17	leave_pass	Data Table	Not currently supported in App			H
18	classes_missed_lv	Data Table	Not currently supported in App			H
19	lookup_fa	Lookup Table	SSMS	Research Team	Rarely	L
20	officer_fa	Data Table	App	Individual	Upon arrival/change	N/A
21	lookup_br	Lookup Table	SSMS	Research Team	Rarely	L
22	officer_br	Data Table	App	Individual	Upon arrival/change	N/A
23	employer	Data Table	Not currently supported in App			M
24	mil_eval_info	Data Table	App	Individual	Upon arrival	L
25	lookup_center	Lookup Table	SSMS	Research Team	Rarely	L
26	center_pos	Data Table	Not currently supported in App			H
27	lookup_committee	Lookup Table	Not currently supported in App			H
28	additional_duty	Data Table	Not currently supported in App			H
29	course_pos	Data Table	Not currently supported in App			H
30	cadets	Data Table	Automatic	ODA AMS connector	Every day at 0500	N/A
31	prospective_fac	Data Table	Not currently supported in App			L
32	lookup_major	Lookup Table	Automatic	ODA AMS connector	Every day at 0500	N/A
33	majors	Data Table	Automatic	ODA AMS connector	Every day at 0500	N/A
34	lookup_awards	Lookup Table	SSMS	Research Team	Rarely	L
35	cadet_awards	Data Table	Not currently supported in App			M
36	projects	Data Table	App	Individual	Project updates	N/A
37	project_pictures	Data Table	App	Individual	Project updates	N/A
38	lookup_topic_methods	Lookup Table	SSMS	Research Team	Rarely	L
39	project_tags	Data Table	App	Individual	Project updates	N/A
40	project_cadet	Data Table	App	Individual	Project updates	N/A

	Name	Type	Update Mode	Responsibility	Frequency	Priority to Enhance
41	project_awards	Data Table	App	Individual	Project updates	N/A
42	lookup_pub_types	Lookup Table	SSMS	Research Team	Rarely	L
43	lookup_pub_venues	Lookup Table	SSMS	Research Team	Rarely	L
44	publications	Data Table	App	Individual	Project updates	N/A
45	project_fac	Data Table	App	Individual	Project updates	N/A
46	lookup_priority	Lookup Table	SSMS	Research Team	Beginning of FY	M
47	priorities	Data Table	App	Individual	Project updates	N/A
48	center_sponsors	Data Table	App	Individual	Project updates	N/A
49	lookup_orgs	Data Table	App	Individual	Updates to orgs	M
50	tbl_dean_or_funding_partners	Data Table	SSMS	Research Team	Updates to orgs	H
51	lookup_sponsors_collaborators	Data Table	App	Individual	Updates to sponsors	M
52	project_collaborators	Data Table	App	Individual	Project updates	N/A
53	lookup_budget_type	Lookup Table	SSMS	Research Team	Rarely	L
54	lookup_funding_type	Lookup Table	SSMS	Research Team	Rarely	L
55	budgets	Data Table	App	Admin	New budgets	N/A
56	budget_notes	Data Table	App	Admin	New budgets	N/A
57	budget_sponsors	Data Table	App	Admin	New budgets	N/A
58	lookup_cost_status	Lookup Table	SSMS	Research Team	Rarely	L
59	add_deposits	Data Table	App	Admin	New deposits	N/A
60	fee_costs	Data Table	App	Admin	New fees	N/A
61	spend_plan	Data Table	App	Admin	Spend plan changes	N/A
62	salary_costs	Data Table	App	Research PD	Regularly for planning	N/A
63	lookup_pay_periods	Lookup Table	App	Research Team	Prior to FY	N/A
64	pay_period_costs	Data Table	App	Research PD	Regularly for planning	N/A
65	salary_cost_notes	Data Table	App	Research PD	Regularly for planning	N/A
66	add_salary_costs	Data Table	App	Research PD	Rarely	N/A
67	lookup_purchase_types	Lookup Table	SSMS	Research Team	Rarely	L
68	lookup_purchase_screening	Lookup Table	SSMS	Research Team	Rarely	L
69	purchase_costs	Data Table	App	Individual	Updates to purchases	N/A
70	purchase_items	Data Table	App	Individual	Updates to purchases	N/A
71	purchase_cost_notes	Data Table	App	Individual	Updates to purchases	N/A
72	project_purchases	Data Table	App	Individual	Updates to purchases	N/A
73	lookup_trip_type	Lookup Table	SSMS	Research Team	Rarely	L
74	lookup_trips	Data Table	App	Travel OIC	Updates to travel	N/A
75	travel_costs	Data Table	App	Individual	Updates to travel	N/A
76	travel_notes	Data Table	App	Individual	Updates to travel	N/A
77	classes_missed_travel	Data Table	App	Individual	Updates to travel	N/A
78	project_travel	Data Table	App	Individual	Updates to travel	N/A
79	aiads	Data Table	SSMS	Research Team	End of summer	M
80	aiad_projects	Data Table	SSMS	Research Team	End of summer	L
81	permissions_admin	Data Table	App	Research Team	Arrival/departure	N/A
82	permissions_S1	Data Table	App	Research Team	Arrival/departure	N/A
83	permissions_master	Data Table	App	Research Team	Arrival/departure	N/A
84	permissions_research	Data Table	App	Research Team	Arrival/departure	N/A

Table 2: Stored view, procedures, and their purposes

	Name	Type	Purpose
1	add_pers_view	View	Faculty at USMA not in D/Math
2	current_fac_view	View	"Current" (within 1 year) D/Math faculty
3	current_degree_view	View	"Current" D/Math faculty degrees
4	current_classes_view	View	"Current" D/Math taught classes within 1 year
5	current_research_classes_view	View	"Current" D/Math taught research classes within 1 year
6	fac_courses_view	View	Number of sections by class and faculty (all)
7	add_duty_view	View	"Current" D/Math additional duties
8	course_pos_view	View	"Current" D/Math course positions
9	current_cadet_view	View	Current cadets
10	current_projects_view	View	"Current" projects (within 2 years)
11	project_tags_view	View	Tags for "current" projects
12	project_priority_view	View	Priorities for "current" projects
13	current_cadet_pubs_view	View	Publications for "current" projects
14	project_collab_org_view	View	All organizations, collaborators, and "current" projects
15	lookup_collab_view	View	All collaborators
16	lookup_org_view	View	All organizations
17	current_budget_view	View	"Current" budgets (up to 2 months expired)
18	budget_notes_view	View	"Current" budget notes
19	budget_sponsor_view	View	"Current" budget sponsors
20	budger_ledger_view	View	"Current" budget costs
21	total_costs_view	View	"Current" budget costs calculation
22	remaining_balance_view	View	"Current" budget balances
23	current_fees_deposits_view	View	"Current" budget fees and deposits
24	salary_costs_view	View	Salary costs in "current" budgets
25	add_salary_view	View	Additional salary costs in "current" budgets
26	salary_notes_view	View	"Current" salary cost notes
27	pay_period_view	View	Current FY pay periods
28	pay_period_cost_view	View	All pay periods (even without cost) for "current" salary costs
29	purchase_cost_view	View	Purchases in "current" budgets
30	purchase_notes_view	View	Notes for "current" purchases
31	current_travel_view	View	"Current" travel (finished within last 3 months)
32	current_trips_view	View	"Current" trips
33	travel_notes_view	View	Notes for "current" travel
34	add_locs_view	View	Additional locations for "current" travel
35	missed_classes_travel_view	View	Missed classes for "current" travel
36	current_permissions_view	View	All permissions
37	view_current_sections_procedure	Procedure	Dynamic filter sections based on upcoming travel dates
38	project_fac_view_procedure	Procedure	Dynamic filter faculty in selected project
39	project_cadet_view_procedure	Procedure	Dynamic filter cadets in selected project
40	aggregate_pd_approval_procedure	Procedure	Apply overall PD approval when last PD approves

Appendix B

Math App Instructional Videos:
https://usarmywestpoint.sharepoint.com/sites/math.administration/Department%20Level%20Documents/Forms/AllItems.aspx?id=%2Fsites%2Fmath%2Eadministration%2FDepartment%20Level%20Documents%2FAdministrative%20Link%20Documents%2FMathApp%20Instructional%20Videos&viewid=192010b5%2D1bf2%2D4e3d%2D841c%2Df4659e134b03

PowerApps and SSMS Code:
https://github.com/christopher-bingman/MathApp