AUGUR

Explosive Analysis

Using Data to Hold Warfare Centers Accountable During Explosive Ordnance Disposal Publications Procedures

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Speaker Bios

Ryan Webster

- Augur: Consulting Director
- 15 years of Experience
  - DoD: Cost, AoA, C-BA
  - DoE/NNSA: APR Audit, BCA
  - EOD, Robotics, UUV, IT/Cyber
- BS Finance
- CCEA
- GAO Cost Guide
- GAO Agile Guide

Robel Semunegus

- Augur: Technical Advisor
- 6 Years of Experience
  - Cost/IMS/Data Analytics
  - AoA, C-BA, Trade Studies
  - EOD, Robotics, UUV, IT/Cyber
- MS Data Science
- BS Engineering (Sys & Info)
- BS Economics
- GAO Agile Guide

Taylor Fountain

- Augur: Analyst
- 2 Years of Experience
  - Cost/Data Analytics
  - Focus on DBS/IT systems
- BS Mathematics
- Research:
  - Experimental Geometry
  - Numerical Methods
  - Virtual Reality

Overview

- Ordnance Publications Process
- Task Origination
- Phase I (Historical Approach)
- Phase II (Current Approach)
- Phase III (Future Objectives)
- Summary

Caveat: All data is sanitized

Categories, hours, countries of origin, and specific examples

Data included in paper is representative but obfuscated

Ordnance Publications Process

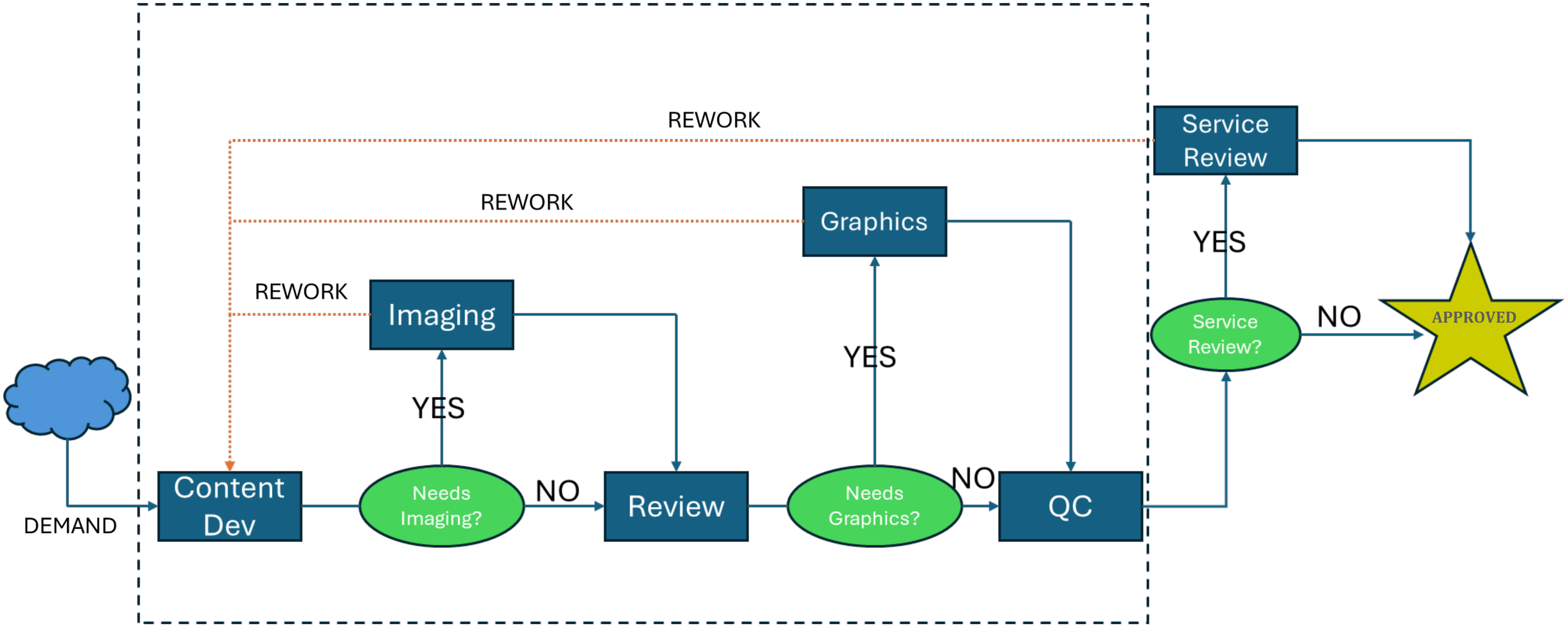
Publications Process

- Referred to as “Pubs”: Explosive Ordnance Disposal (EOD) Manuals
  - Search Wikipedia for “Mines” (~300 mines with hyperlinks and sources)
  - Imagine the DoD wiki where “Mine” is only one of twenty categories
- Additional forks/links for:
  - Land, water, air, chemical, nuclear
  - Anti vehicle, anti person,
  - Instructions, procedures, images
  - Ordnance, component, fuse

Shaped charge/Misnay Schardin effect [edit]

- Adrushy mine
- ARGES mine
- AT2 mine
- ATM 6 mine
- ATM 7 mine
- ATM 2000E
- BAT/7 mine
- FFV 016 mine
- FFV 028 mine
- HAK-1 mine
- Hohl-Sprung mine 4672
- HPD-1 mine
- HPD-2 mine
- HPD-3 mine
- M-24 mine
- MC-71 mine
- MIACAH F1 mine
- MI AC Disp F1 Minotaur mine
- MIFF mine
- Mine Anti-Tank Non-detectable 1A
- Mine Anti-Tank Non-detectable 3A
- MN-111 mine
- MN-121 mine
- MN-123 mine
- MPB mine
- MSM MK2 mine
- MUSA mine
- MUSPA mine
- PT Mi-P mine
- PT Mi-U mine
- PTM-3 mine
- Pz Mi 88 mine
- SATM mine
- SB-MV/1 mine
- SLAM mine
- T-93 mine
- TM-72 mine
- TM-83 mine
- TM-89 mine
- TMK-2 mine
- TMRP-7 mine
- Type 84 mine

Process Overview



Task Origination

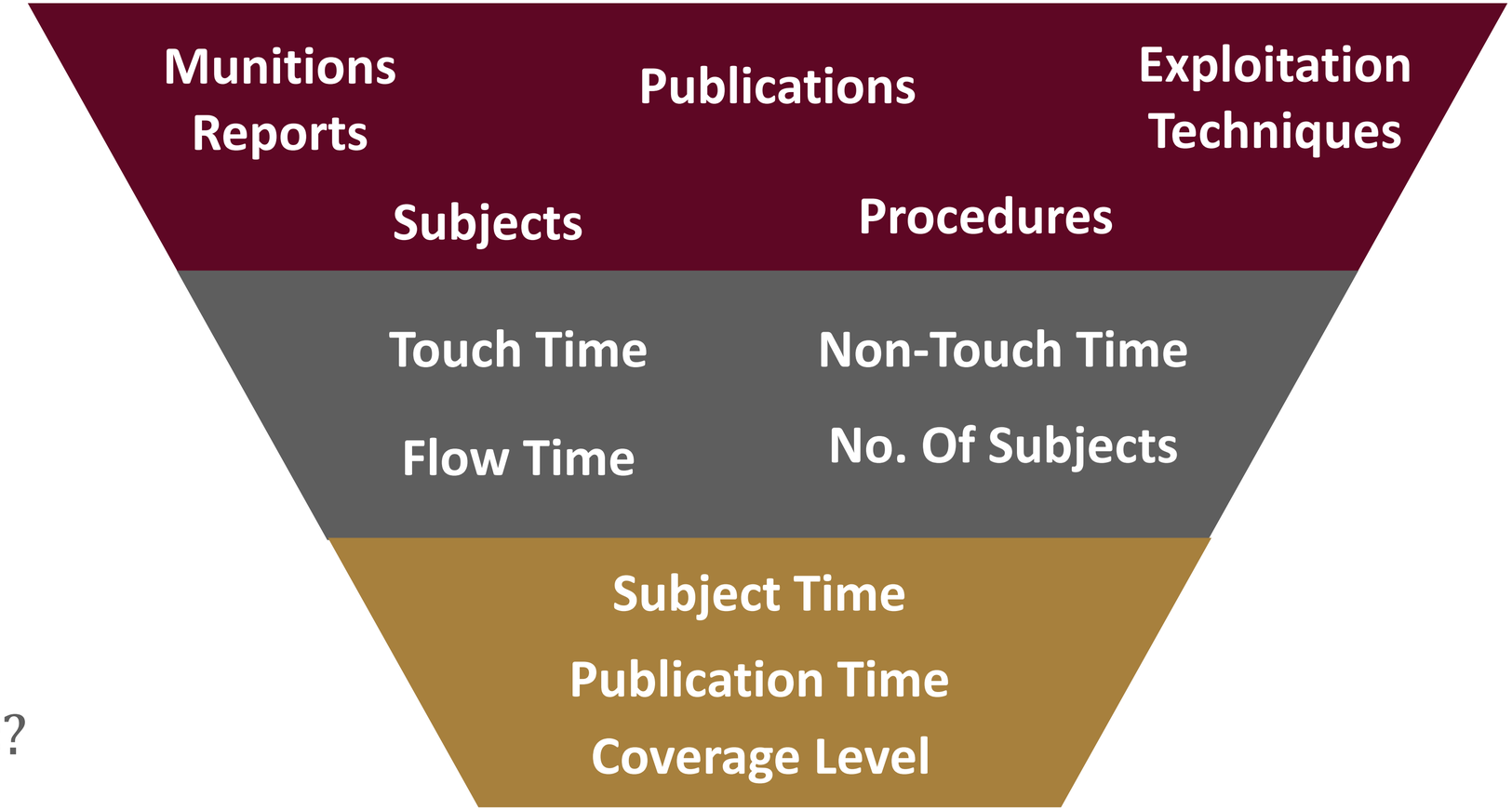
Task Origination

- What's the problem?
  - Warfare Center is essentially a sole source vendor
  - They tell the government how much money they need (NEPS Request)
  - Historically, no ability to perform independent estimate
  - No ability to measure performance/success
    - Limited to quantity metrics (treats all pubs equally)
- Workflow tool that tracks time by "Information Set"
  - Government was not using this information
  - **Augur:** "Give us the data"

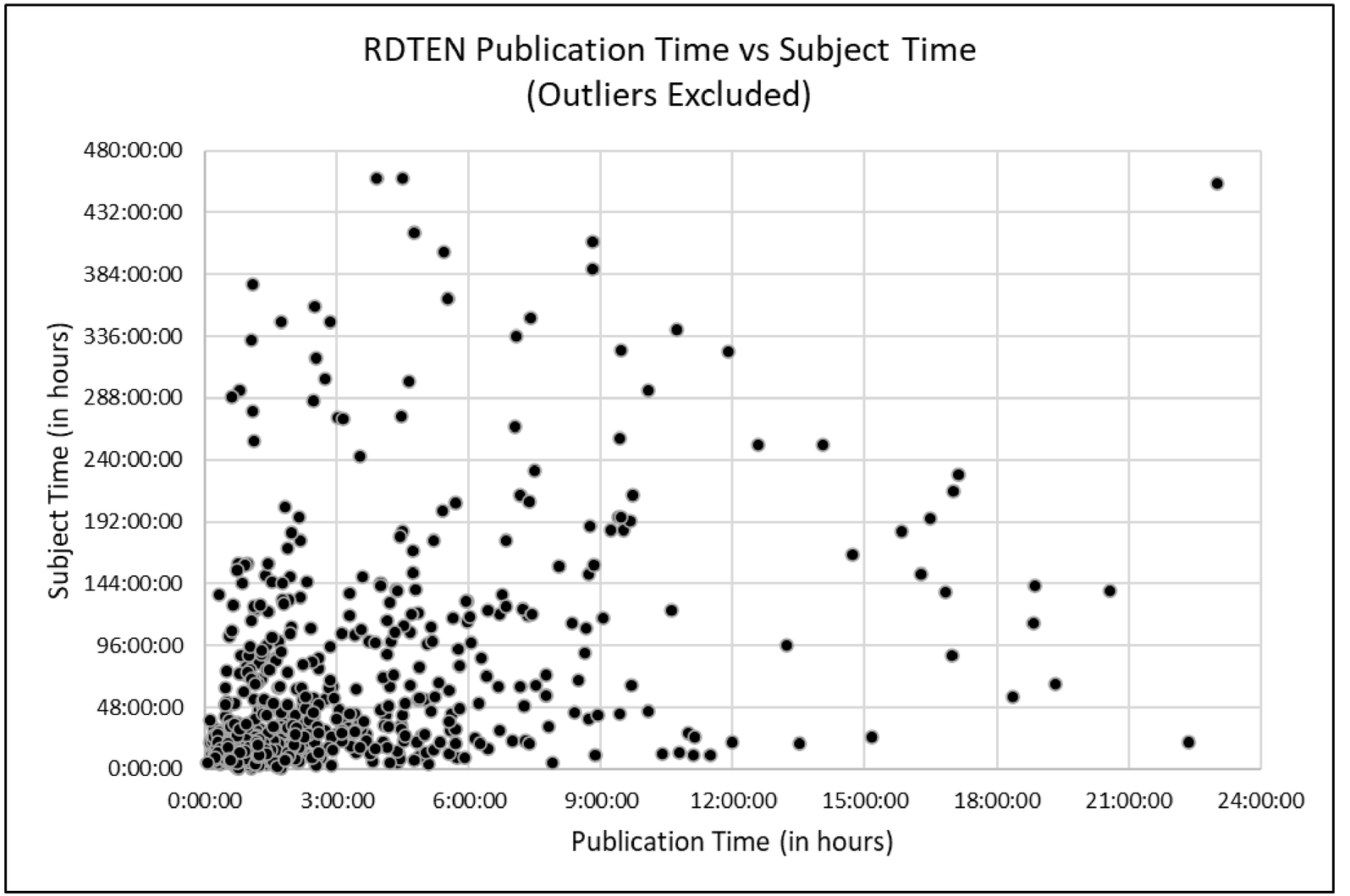
Phase I (Historical)

Initial Dataset

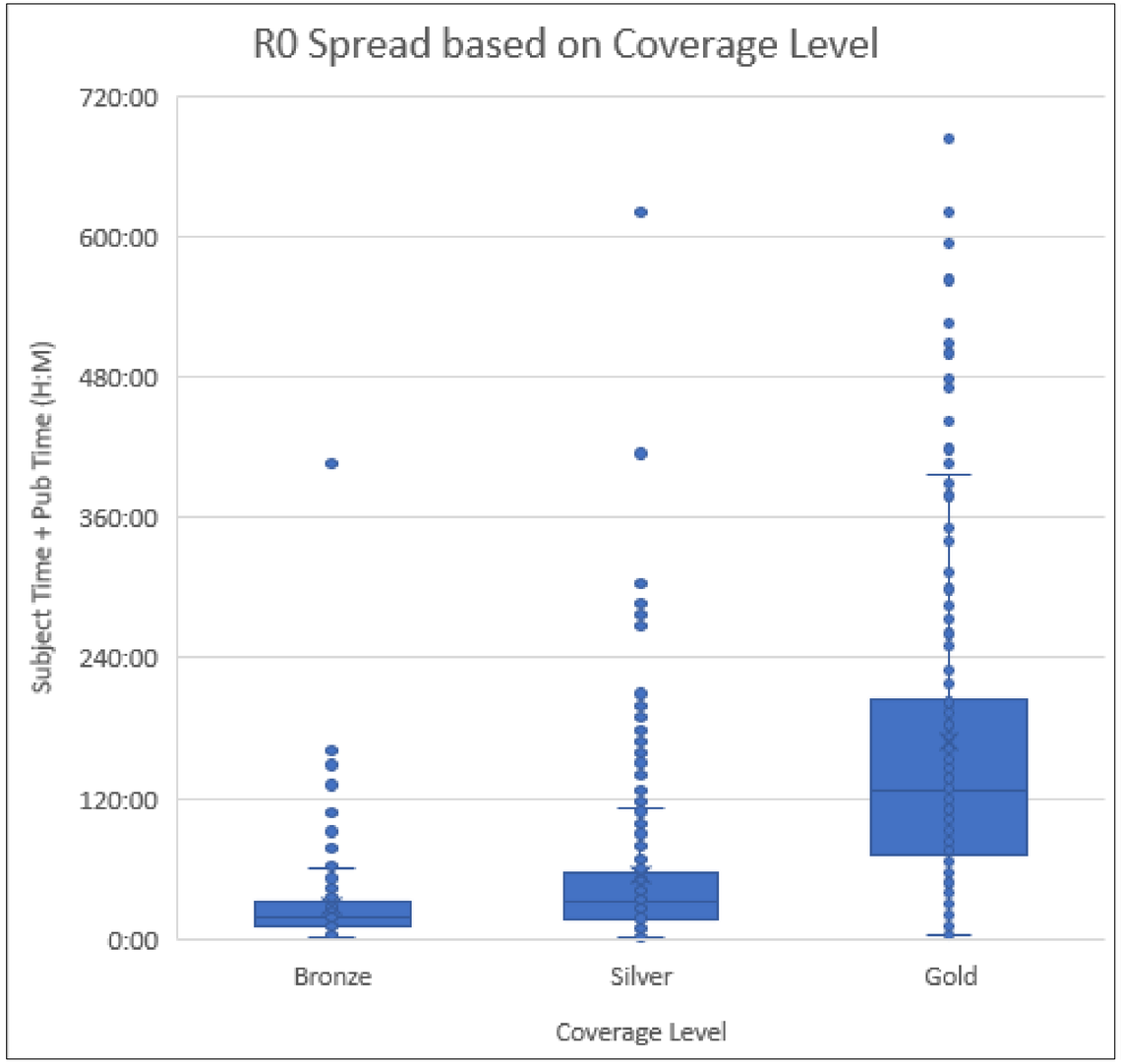
1. How does the publications process work?
2. What components of the publications process are tracked in the tool?
3. From which fields can we extract meaningful insights?

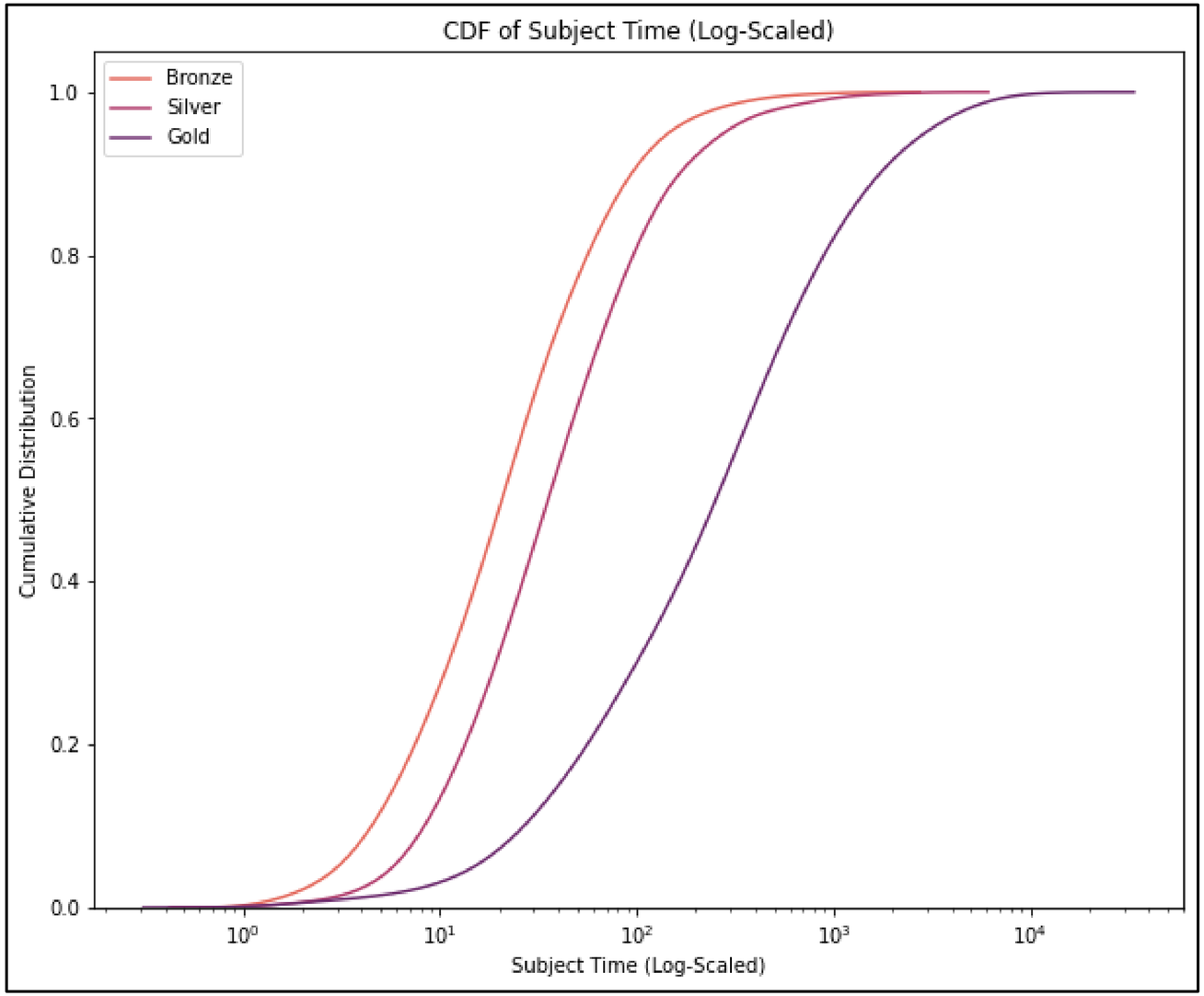


Pub Time vs Sub Time



One Clear Diver





Estimating By Coverage Level (Initial Approach)

- **Works well for:**
  - Long range planning
    - Appropriate for estimating the next 500 Pubs
  - High level crosscheck for near term actuals
- **Shortfalls:**
  - Near term detail planning
    - Not great at estimating the next 10 Pubs
  - Fair “credit” for large effort anomalies
  - Single variable produces highly generalized results
  - No ability to meaningfully measure performance

Phase II (Current)

Back to The Data

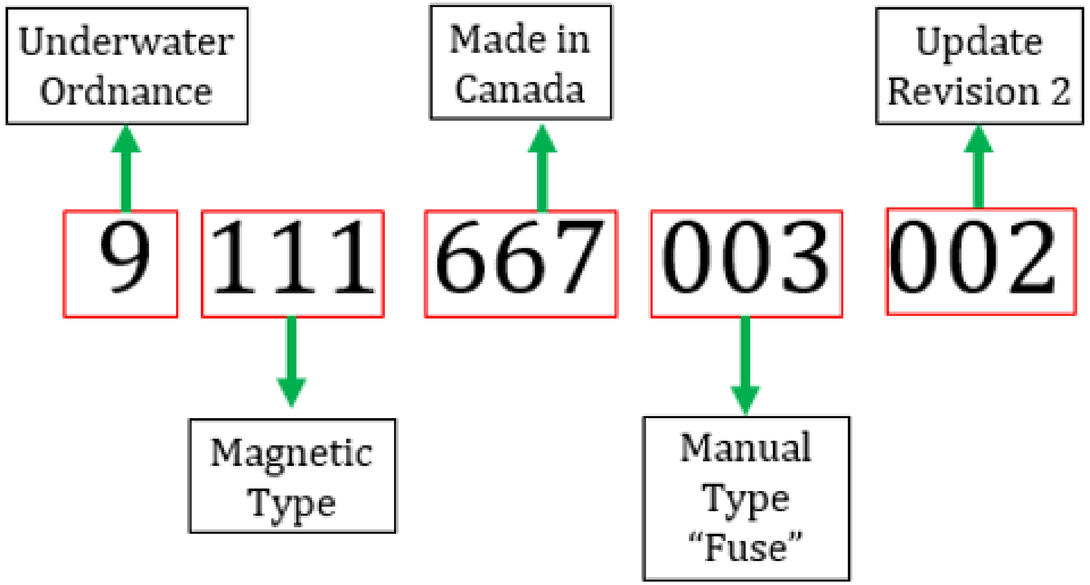
- Reviewed manuals and guidance
- Working groups with content developers
- What else can the data tell us?
  - Can we slice the data by other variables, so far not displayed?
    - Ordnance Type (Landmine, Missile, Underwater, Nuclear)
    - Manual Nature (Full ordnance, Single Component, Fuse Only, etc)
    - Country of Origin

Publication Serial Number – Notional Rubric

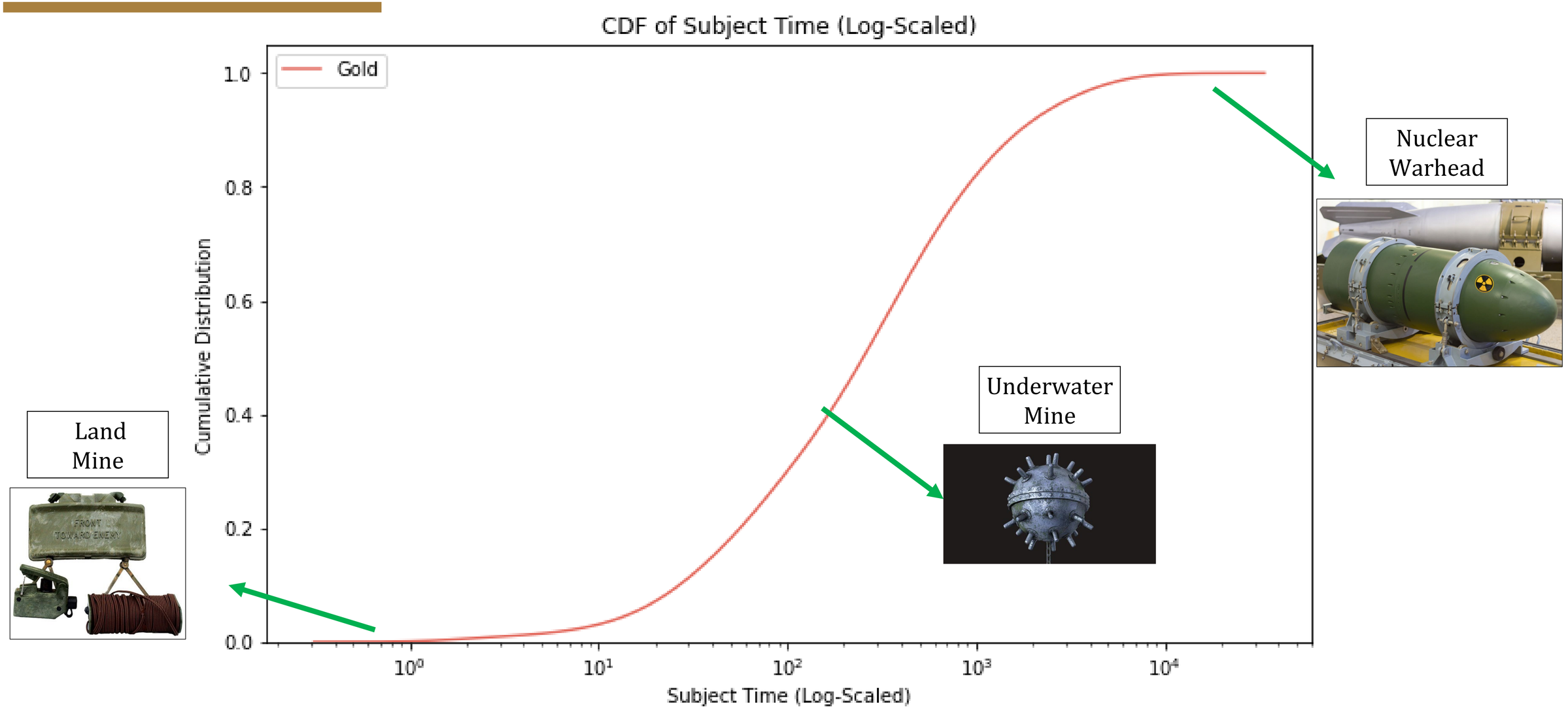
Initial Serial Number View:

911166700300 2

Rubric Example:



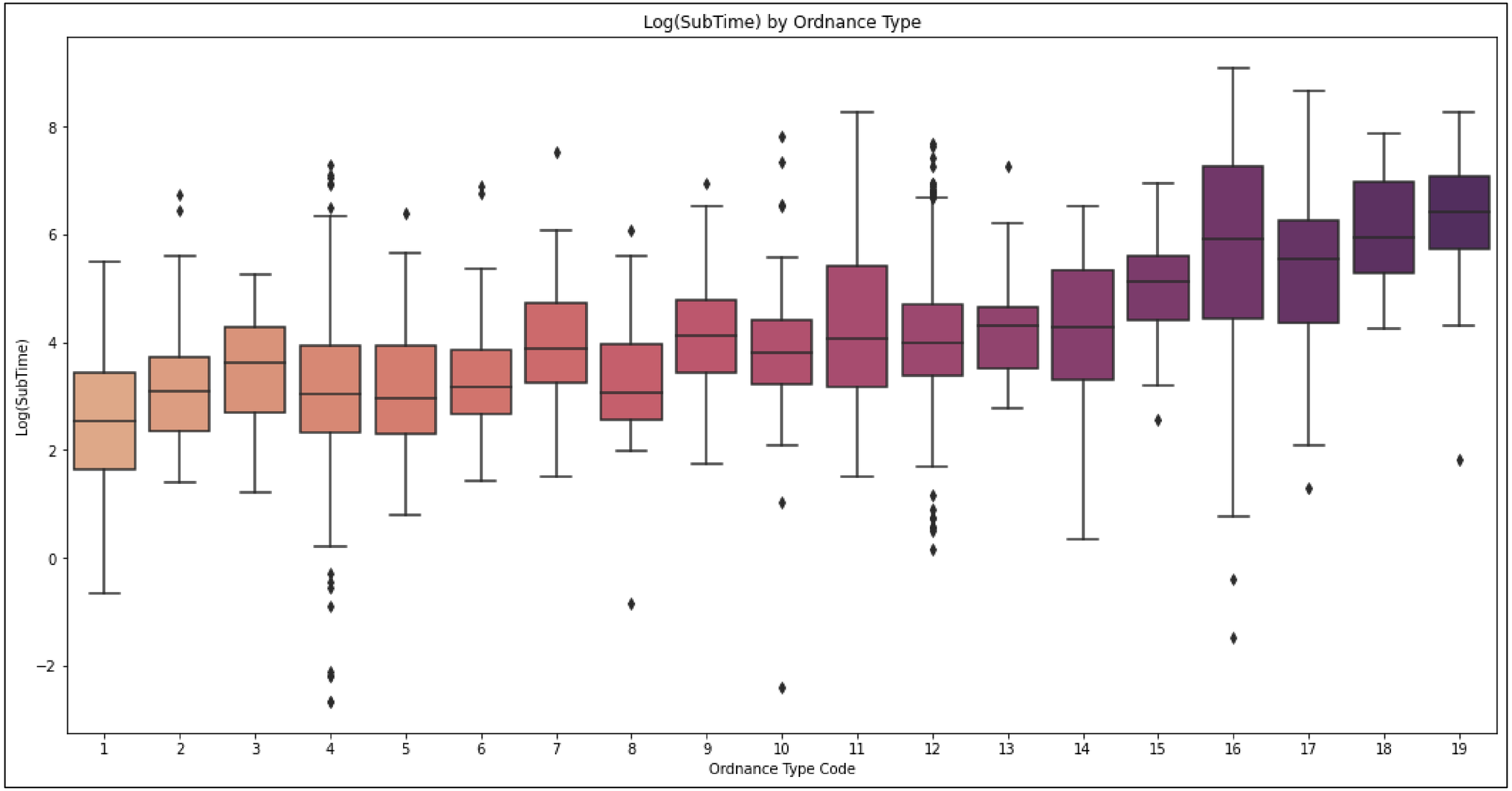
Coverage Level Gold - Notional Examples



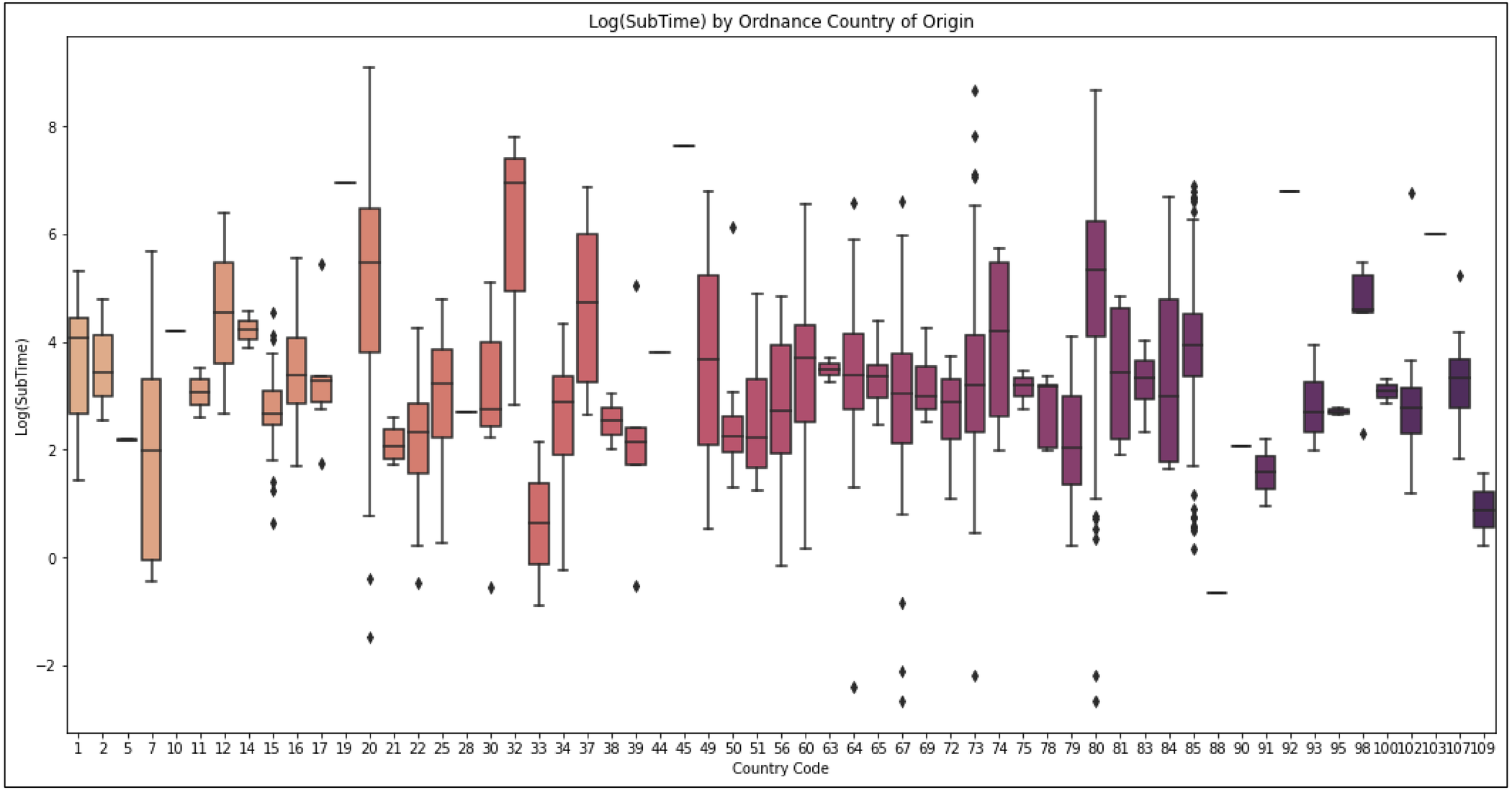
Category Encoding

- **One-Hot Encoding:** N categories → N-1 Boolean columns
  - Easy to interpret, good for low cardinality columns
  - Not good for high cardinality, potential for overfitting
- **Ordinal:** N Categories → 1-N rank among other categories
  - Efficiently encodes high-cardinality categorical data
  - Requires defendable ranking criteria
- **Target Encoding:** Category → Mean of the response
  - Efficiently encodes non-ranked high-cardinality categorical data
  - Assumes mean is representative of the whole category

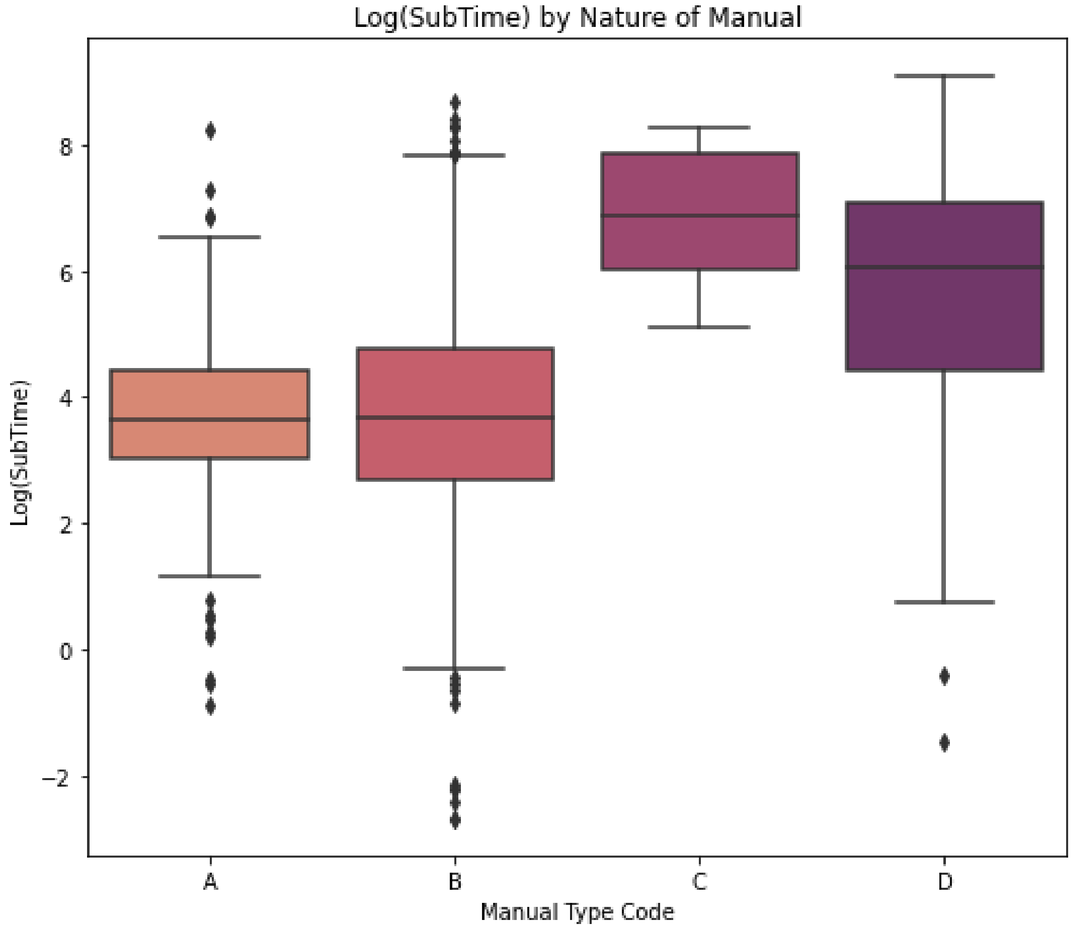
Ordnance Type

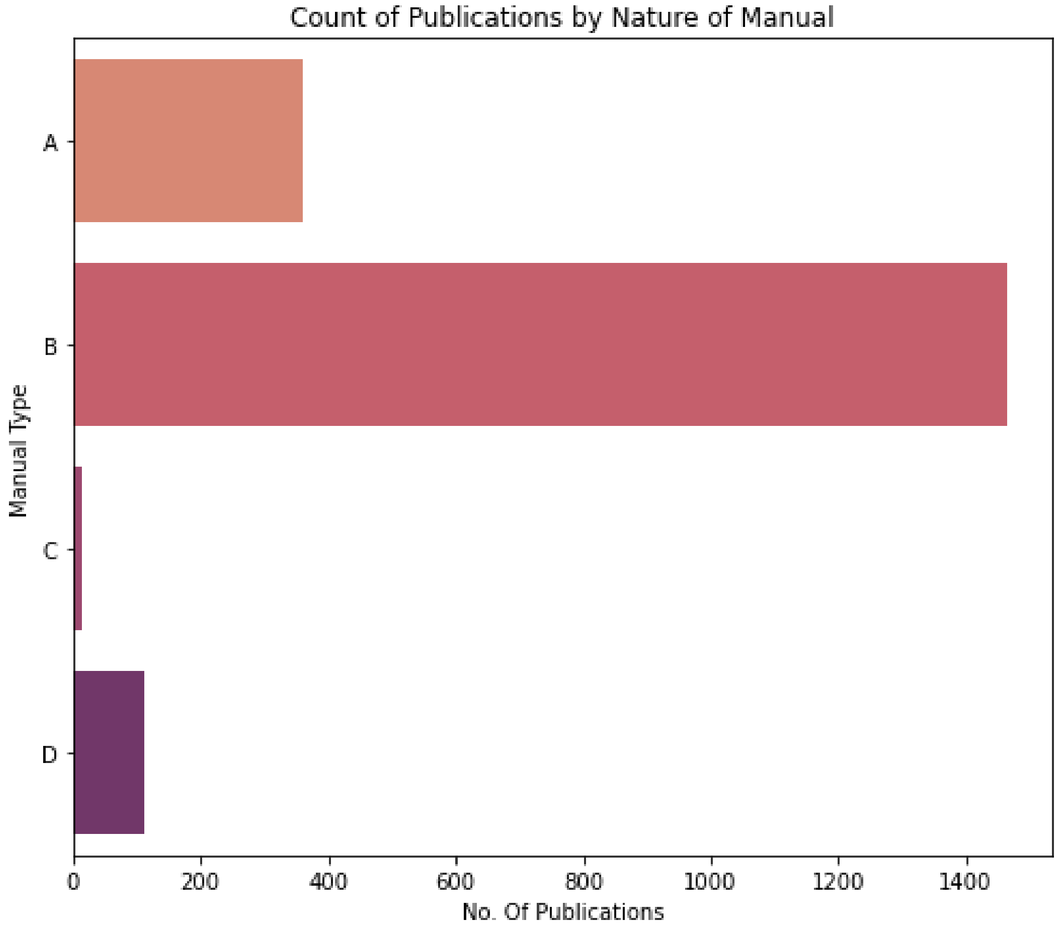


Country of Origin

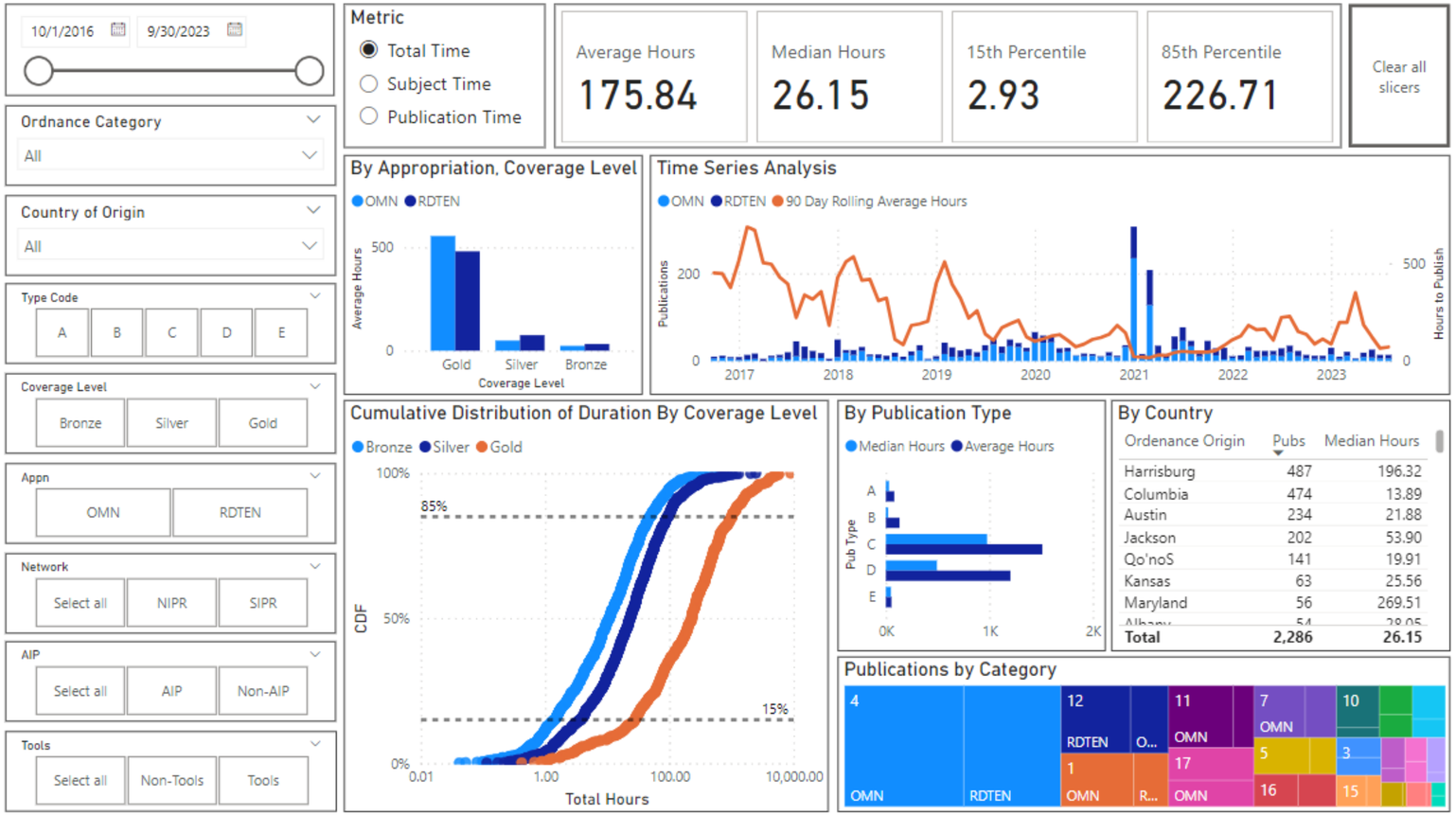


Nature of Manual





Preliminary Findings



Let the Data lead the Science!

Calculator Prototype

Calculator: Objective and Benefit

- Enable Navy leadership to detail plan yearly requirements
  - Expected hours and costs per publication from a non-biased source
- Leverage historical data to estimate hours by publication
  - Displayed as an uncertainty range (every publication is unique)
  - Traceability to publication type
    - Landmine, Underwater Mine, Missile
  - Delineate new publication vs revisions (impacts effort & appropriation)
    - New: RDT&E
    - Revision: O&S

Step 1: User Inputs

User fills out the features in the below image. Each row represents a separate publication. Data validation is applied to avoid erroneous inputs

	User Inputs					
#	Publication Name	Appropriation	Ordnance Type	Country of Origin	Nature of Manual	Coverage Level
1	A1	RDTEN	Unk	Unk	Unk	Unk
2	A2	RDTEN	7	Unk	Unk	Unk
3	A3	RDTEN	Unk	72 - Cheyenne	Unk	Unk
4	A4	OMN	Unk	Unk	B	Unk
5	A5	RDTEN	Unk	Unk	Unk	Gold - Procedure
6	A6	RDTEN	7	80 - Harrisburg	B	Gold - Procedure
7	A7	OMN	17	32 - New York	Unk	Unk
8	A8	RDTEN	Unk	20 - Maryland	D	Unk
9	A9	OMN	Unk	Unk	A	Bronze - Technical Information
10	A10	RDTEN	2	Unk	Unk	Silver - Functioning and/or Appearance
11	A11	RDTEN	9	Unk	B	Unk
12	A12	OMN	Unk	65 - Baton Rouge	Unk	Gold - Procedure
13	A13	OMN	11	80 - Harrisburg	C	Unk
14	A14	RDTEN	Unk	10 - Georgia	B	Gold - Procedure
15	A15	OMN	8	64 - Austin	Unk	Silver - Functioning and/or Appearance
16	A16	OMN	17	Unk	B	Gold - Procedure

Features that are unknown by the user are not considered in the publications' projection

Calculator calls out any input where publication has exceeded the maximum/desired coverage level in red text

Step 2: Review Calculator Outputs

Projected Hours (Per Publication)									
	Sub Time			Pub Time			Total Time		
#	Low	Medium	High	Low	Medium	High	Low	Medium	High
1	4.96	29.97	238.73	0.12	1.08	4.58	5.08	31.05	243.31
2	3.36	30.61	114.23	0.22	1.15	2.98	3.58	31.76	117.22
3	23.95	23.95	23.95	0.31	0.31	0.31	24.26	24.26	24.26
4	1.47	17.73	128.21	0.07	0.73	4.04	1.54	18.46	132.25
5	45.24	257.81	916.07	0.74	2.97	7.70	45.98	260.78	923.77
6	82.10	114.33	129.37	0.72	1.16	1.28	82.82	115.49	130.65
7	746.53	1640.05	2067.71	5.15	14.28	29.86	751.68	1654.33	2097.57
8	28.93	228.31	929.63	0.52	2.78	7.25	29.45	231.09	936.88
9	0.87	5.68	36.38	0.06	0.44	1.78	0.93	6.12	38.15
10	4.39	16.56	22.48	0.28	0.95	2.11	4.68	17.51	24.59
11	0.42	7.31	45.45	0.00	0.12	3.89	0.42	7.43	49.34
12	79.79	79.79	79.79	0.84	0.84	0.84	80.63	80.63	80.63
13	625.55	1546.16	3790.16	7.19	23.26	51.79	632.74	1569.42	3841.95
14	-	-	-	-	-	-	-	-	-
15	17.51	26.45	43.25	0.73	1.51	1.54	18.24	27.96	44.79
16	49.91	414.42	1629.68	1.21	4.92	22.62	51.13	419.34	1652.30

Step 3: Review Summary Outputs

Publication Total Funding Summary Table					
Publication Info			Total Funding Range ($)		
#	Publication Name	# of Data Points	*Low*	*Medium*	*High*
1	A1	1152	$ 915	$ 5,588	$ 43,796
2	A2	55	$ 645	$ 5,717	$ 21,099
3	A3	1	$ 4,367	$ 4,367	$ 4,367
4	A4	1049	$ 278	$ 3,323	$ 23,805
5	A5	254	$ 8,277	$ 46,940	$ 166,278
6	A6	3	$ 14,908	$ 20,788	$ 23,517
7	A7	4	$ 135,303	$ 297,779	$ 377,563
8	A8	31	$ 5,300	$ 41,596	$ 168,638
9	A9	60	$ 167	$ 1,101	$ 6,867
10	A10	10	$ 842	$ 3,151	$ 4,426
11	A11	7	$ 76	$ 1,337	$ 8,881
12	A12	1	$ 14,513	$ 14,513	$ 14,513
13	A13	11	$ 113,892	$ 282,496	$ 691,550
14	A14	0	-	-	-
15	A15	3	$ 3,284	$ 5,033	$ 8,062
16	A16	48	$ 9,203	$ 75,480	$ 297,415

Phase III (Future)

Path Forward

- Direct access to system data
  - Continued data cleanup
  - Revised Calculator
- Custom fields in workflow manager
  - Information set “status”
  - Methods for claiming credit
  - Repeatable monthly custom report
- Baseline Event (IBR-like)
  - Enables Performance Management

Work In Process (Notional)	
Status	Credit
Subject Created	0%
Documentation Started	10%
Submitted to Tech Editing	25%
Documentation Complete	50%
Imaging Complete	60%
Graphics Complete	70%
Submitted for Review	80%
Submitted for Approval	90%
Published	100%

Performance Dashboard

Value:

- Value of work accomplished (Value of completed tasks + value of WIP vs baseline)
- Backlog burn down

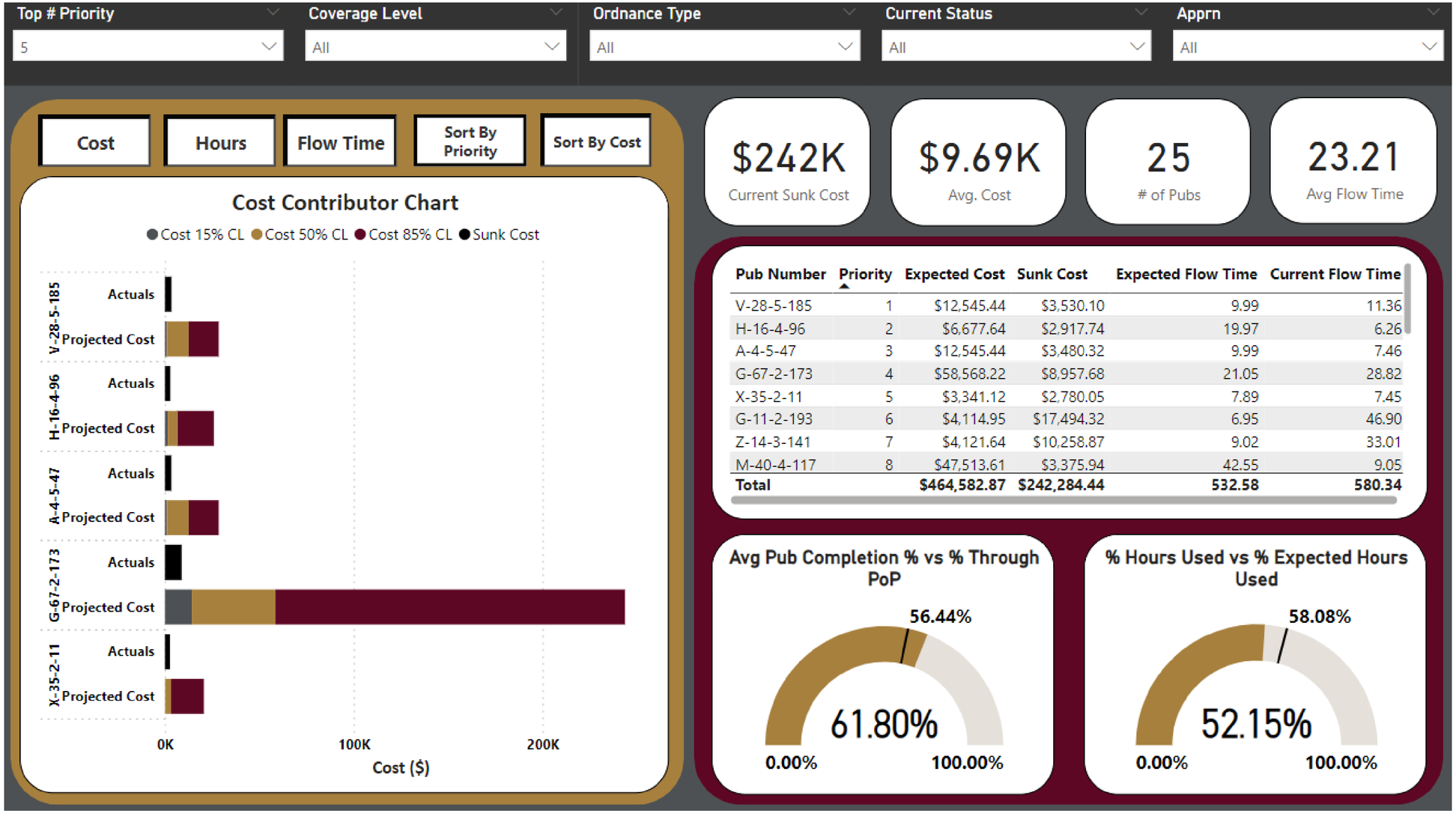
Variance:

- Hours per Information Set (Cost of labor hours, planned vs actual)
- Flow Time of each Information Set (Schedule durations, planned vs actual)

Quality:

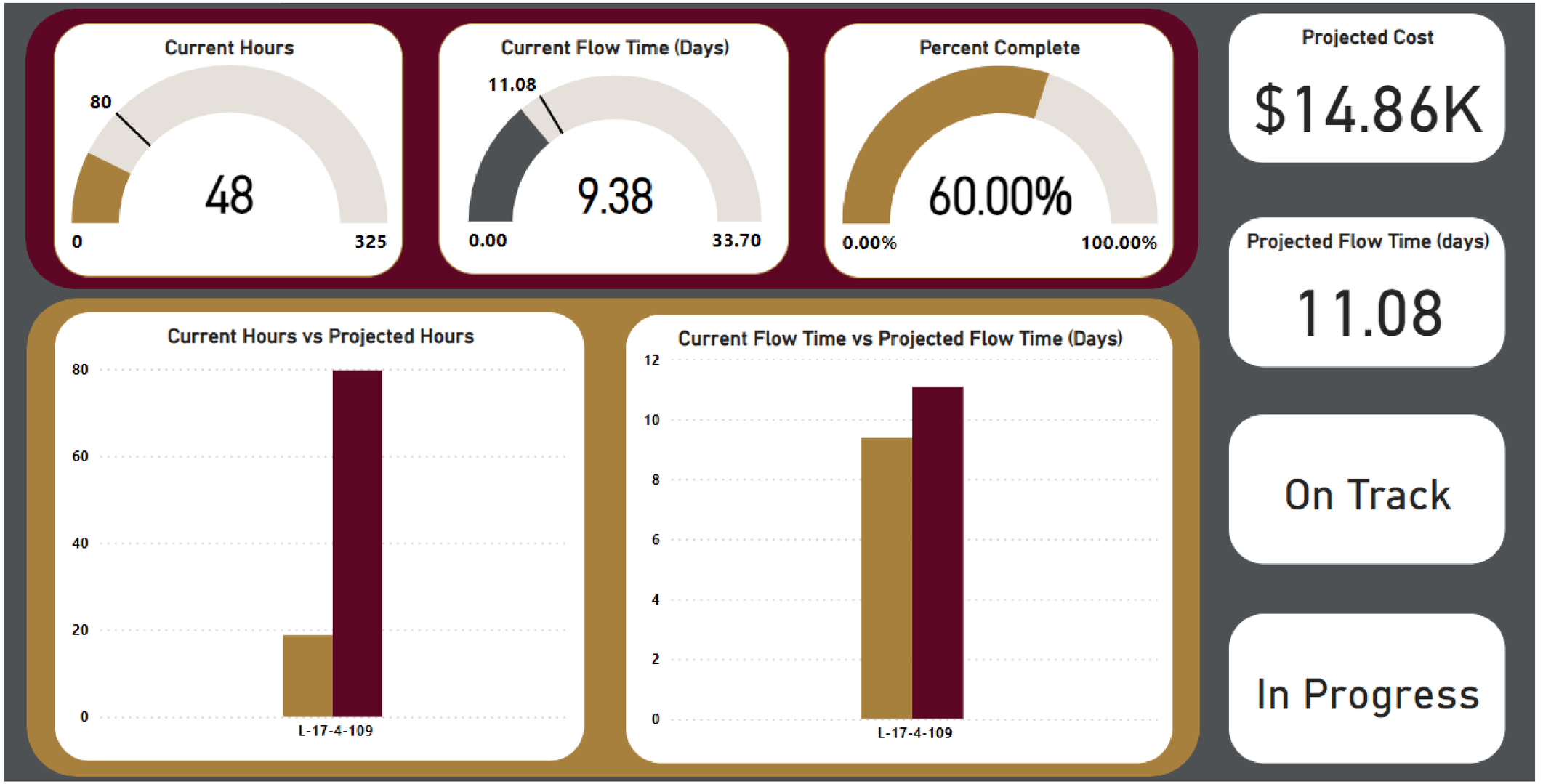
- Internal rework instances
- External requests for revisions due to lack of completeness or errors

Summary Dashboard (Overview)



Pub Number	Priority	Expected Cost	Sunk Cost	Expected Flow Time	Current Flow Time
V-28-5-185	1	$12,545.44	$3,530.10	9.99	11.36
H-16-4-96	2	$6,677.64	$2,917.74	19.97	6.26
A-4-5-47	3	$12,545.44	$3,480.32	9.99	7.46
G-67-2-173	4	$58,568.22	$8,957.68	21.05	28.82
X-35-2-11	5	$3,341.12	$2,780.05	7.89	7.45
G-11-2-193	6	$4,114.95	$17,494.32	6.95	46.90
Z-14-3-141	7	$4,121.64	$10,258.87	9.02	33.01
M-40-4-117	8	$47,513.61	$3,375.94	42.55	9.05
Total		**$464,582.87**	**$242,284.44**	**532.58**	**580.34**

Summary Dashboard (Single Task)



Summary

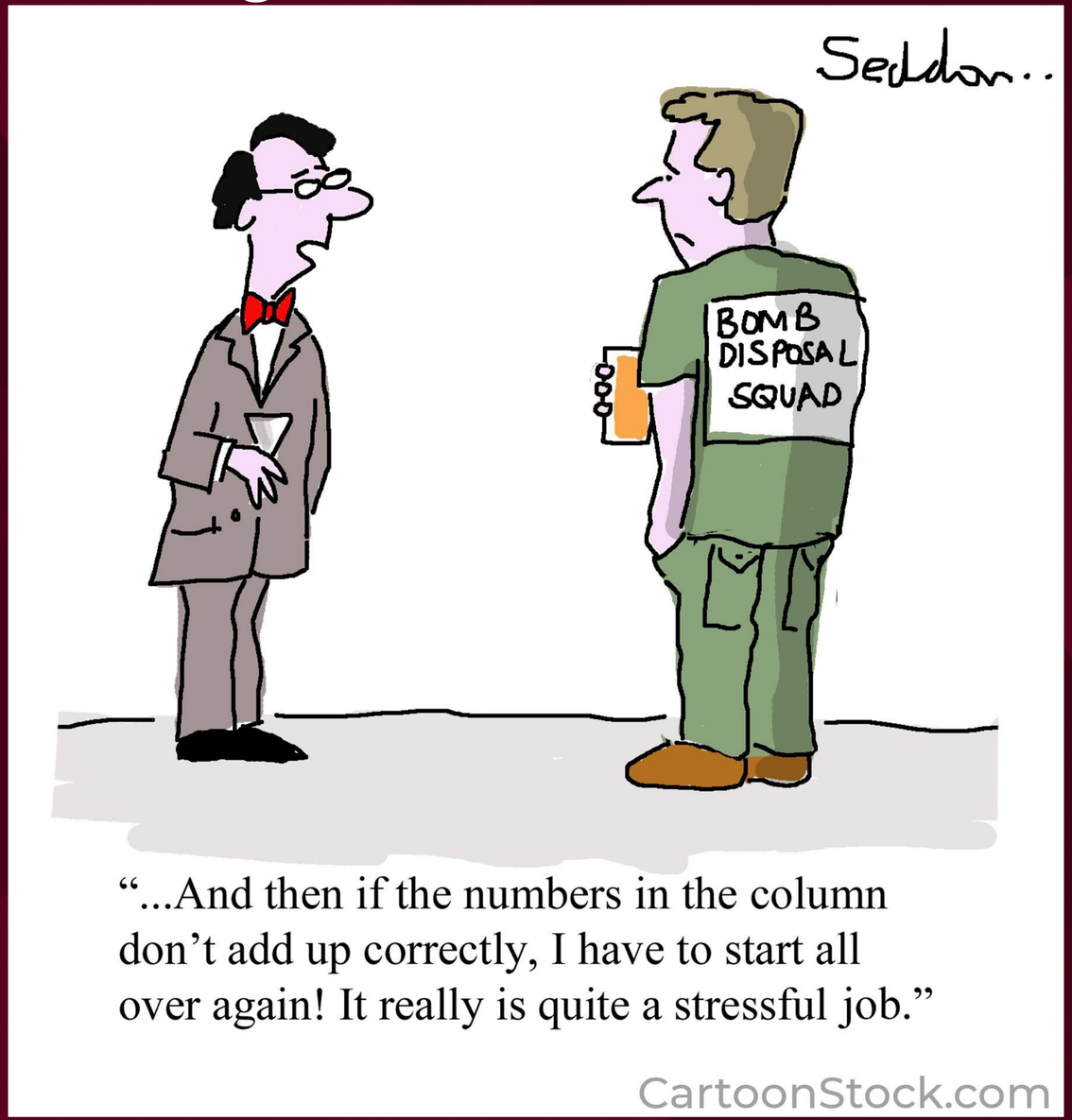
Summary

- **Phase I**
  - Estimated values by Coverage Level only
  - Still appropriate for long range planning
- **Phase II**
  - Slice data further by Ordnance Type, Country of Origin, Nature of Manual
  - Enables detail planning for a single OY
- **Phase III**
  - Real time access to system
  - Use data to baseline annual scope and measure performance

Lessons Learned

- Warfare Centers should be held accountable just like vendors
- Never believe “It’s impossible to estimate what we do here”
- Use the data you can get at the time
- Ask the right questions
- Get direct access to source data
- Automate what you can

Questions


Seldon...
BOMB DISPOSAL SQUAD
"...And then if the numbers in the column don't add up correctly, I have to start all over again! It really is quite a stressful job."
CartoonStock.com

Back-Up Definitions

1) **Individual Subjects** – *Store all information, graphics, and tables on an item (i.e., bomb, missiles, etc.). May also cover broader concepts such as general information, tools, or explosives and EOD-related hazardous materials.*

2) **Munitions Data Reports -** *Digital copies of ordnance details including CT scanned images which enable 3-D rendering of each component. These details are used to develop procedures and exploitation techniques.*

3) **Exploitation Techniques** – *The process of obtaining assets and evaluating and establishing techniques to render an ordnance safe in a controlled manner. Once a process is proven multiple times, this technique can be documented and published. Much of the required effort will not show up in the workflow tracker as it precedes documentation. Reverse engineering, may include disrupt process (detonate)*

4) **Render Safe & Disposal Procedures** – *This product is a result of performing tests and establishing steps to enable an ordnance safe for handling. An example would be cutting or removing a fuse followed by disposal of the explosive component. Much of the required effort will not show up in the workflow tracker as it precedes documentation.*

5) **Publications –** *The formal product consisting of packaging, labeling, bundling, and publishing any combination of the prior listed information sets. Not all information sets require this step.*

Back-Up Definitions

- **Touch Time** – Captures time spent working directly on subjects that are not tied to a publication. For example, writing and formatting a subject.
- **Non-Touch Time** – Captures time spent on any ancillary work to support a subject not tied to a publication. May include research, testing, and other work needed to develop a subject.
- **Publication Time** – Captures time spent working directly on publications; does not include any time spent working on subjects tied to the publication. For example, publication time captures the formatting of the publication and process to package subjects together that form the publication. Typically, publication time is shorter than subject time for a given publication.
- **Subject Time** – Captures time spent developing or revising subjects that are tied to a publication. The subject time for a single publication captures the sum of the Touch Time and Non-Touch Time for all subjects tied to that publication. Includes research, testing, and other work necessary to create and revise a subject. This typically captures most of the time needed to create or revise a given publication.