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MODIFIED DYNA-METRIC (DYNAMIC MULTI-ECHELON TECHNIQUE
FOR RECOVERABLE INV. (U) AIR FORCE LOGISTICS COMMAND
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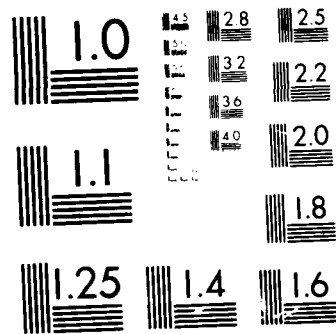
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MODIFIED DYNA-METRIC:
FINDING THE LEAST COST MIX
OF WARTIME SPARES

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LT COL DOUGLAS BLAZER
Chief, Analysis and Information Mgt Division
HQ Air Force Logistics Command

and

PROFESSOR DOUG RIPPY
Systems and Applied Sciences Corporation

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HEADQUARTERS AIR FORCE LOGISTICS COMMAND
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6 APR 1988

SUBJECT Final Report Modified Dyna-METRIC: Finding the Least Cost Mix of Wartime Spares

TO SEE DISTRIBUTION LIST

1. The attached report (Atch 3) compares the cost and stockage performance of War Readiness Spares Kits (WRSKs) computed using a modified Dyna-METRIC model. The modified Dyna-METRIC model finds the least cost mix of line replaceable units (LRUs) and shop replaceable units (SRUs) required to meet a given weapon system support objective. The modified Dyna-METRIC computes Remove, Repair and Replace (RRR) WRSK that provide equal combat capability at \$.76 to \$3.46 million less cost per kit than the (unmodified) Dyna-METRIC model. Modified Dyna-METRIC will also compute the spares needed to maximize combat capability with limited war spares funding, a capability we need for war spares budget execution.

2. We intend to implement the modified Dyna-METRIC as part of the Weapon System Management Information System (WSMIS) Requirements Execution Availability Logistics Module (REALM) in May 1988. Until the modified Dyna-METRIC is implemented, we will use Dyna-METRIC to compute WRSK requirements beginning in March 1988. The (unmodified) Dyna-METRIC model will compute three separate WRSK for RRR kits and select the least cost of the three kits. Per a recommendation from HQ TAC, the three options will stock SRUs to achieve an 80, 85 and 90 percent probability of meeting each SRU's demands. Our conclusions and recommendations are provided in Atch 1.

3. Our point of contact is Lt Col D. Blazer, HQ AFLC/MMMA, AUTOVON 787-5243.

FOR THE COMMANDER

Charles B. Johnson

- 3 Atch
1. Conclusions and Recommendations
2. Distribution List
3. Final Report

UNITED STATES AIR FORCE



SEPTEMBER 18, 1947

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The Dyna-METRIC model computes War Readiness Spares Kits (WRSKs) that provide the same combat capability as the current War Requirements Computation System (DO29) but at reduced cost.
2. Although Dyna-METRIC accurately considers indenture relationships, it does not compute the lowest cost mix of line replaceable units (LRUs) and shop replaceable units (SRUs).
3. The Modified Dyna-METRIC model computes the lowest cost mix of LRUs and SRUs, thereby reducing the Air Force's requirements cost from \$.76 to \$3.46 million per repair, remove and replace (RRR) kit.
4. The Modified Dyna-METRIC model should be included in the Weapon System Management Information System (WSMIS) Requirements Execution Availability Logistics Module (REALM) because it computes kits that provide the same combat capability at even less cost than (the unmodified) Dyna-METRIC and it computes the spares needed to maximize aircraft availability with limited funds.
5. Until the modified Dyna-METRIC model is implemented, REALM will compute WRSK using the least cost of three Dyna-METRIC computations. The three options will be to compute SRUs to achieve an 80, 85 and 90 percent probability of meeting each SRU's demands.
6. The WSMIS contractor, Dynamics Research Corporation, is currently implementing the modified Dyna-METRIC model into REALM in order to compute Air Force WRSK requirements and to maximize combat capability with limited war spares funding by May 1988.

Recommendations

1. Implement the Modified Dyna-METRIC model within WSMIS/REALM. (OPR: HQ AFLC/MMM and LMSC/SMW)
2. Use the Modified Dyna-METRIC model to compute both full funding and limited funding Air Force WRSK requirements. (OPR: HQ AFLC/MMM)

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ABSTRACT

This report compares the cost and stockage of a War Readiness Spares Kit (WRSK) computed using the Dyna-METRIC model to a WRSK computed using a modified Dyna-METRIC model. The modified Dyna-METRIC model finds the least cost mix of line replaceable units and shop replaceable units required to meet the wartime weapon system performance objective. The modified Dyna-METRIC model computes Remove, Repair, and Replace (RRR) WRSK that provide equal combat capability at \$.76 million to \$3.46 million less cost than the (unmodified) Dyna-METRIC model.



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EXECUTIVE SUMMARY

Neither the current War Requirements Computation System (DO29) nor the current Dyna-METRIC model, which is scheduled to replace the DO29 system in March 1988, computes the least cost mix of war spares requirements. In this study, we compared the cost and stockage performance of a modified Dyna-METRIC model, which finds the least cost mix of war spares, to the current Dyna-METRIC model. The modified Dyna-Metric model computes kits that are \$.76 to \$3.46 million less than the (unmodified) Dyna-METRIC model and achieves the same combat capability. Generally this requirement cost savings is attained because the modified Dyna-METRIC stocks fewer line replaceable units and more lower cost shop replaceable units. The modified Dyna-METRIC model also provides the capability to compute the spares needed to maximize combat capability given a funding limitation. The Air Force Logistics Command intends to implement the modified Dyna-METRIC model in the Weapon System Management Information System (WSMIS) Requirements Execution Availability Logistics Module (REALM).

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CHAPTER 1

THE PROBLEM

Neither the current War Requirements Computation System (DO29) nor the current Dynamic Multi-Echelon Technique for Recoverable Inventory Control (Dyna-METRIC) model, which is scheduled to replace the DO29 system, compute the least cost mix of war spares requirements because they fail to optimally consider indenture relationships. Although Dyna-METRIC accurately considers the impact of the line replaceable units (LRUs) to shop replaceable units (SRUs) relationship, it does not compute the minimum cost mix of spares to meet wartime requirements. In an earlier report [1], we recommended the Air Force use the Dyna-METRIC to compute war readiness requirements. We also recommended additional research to modify Dyna-METRIC to compute the least cost mix of spares to compute WRSK requirements. Dyna-METRIC computes Remove, Repair and Replace (RRR) kits that provide equal combat capability (in terms of mission capable aircraft) at less cost than the current system (DO29). Dyna-METRIC achieves those reduced costs, because it accurately considers indenture levels, that is, Dyna-METRIC considers the lack of an SRU on its next higher assembly, the LRU. Dyna-METRIC does not ground the weapon system due to the lack of an SRU, unless the SRU's non-availability causes the lack of an LRU. Although Dyna-METRIC realizes cost savings because it accurately considers indenture relationships, it does not compute the optimum (least cost) mix of LRUs and SRUs.

OBJECTIVES:

1. Develop the programming code to optimally (minimum cost) compute WRSK requirements.
2. Compare the cost and performance of a modified Dyna-METRIC model that optimally computes war requirements to the existing Dyna-METRIC model.
3. Investigate implementation issues and, if appropriate, recommend implementation of an optimal modified Dyna-METRIC war requirements model.

BACKGROUND:

The Air Force Logistics Command (AFLC) previously developed a war requirement computation algorithm that found the least cost mix of spares considering indenture relationship as part of the Wartime Assessment and Requirement Simulation (WARS) program. WARS was a research and development analysis effort to identify ways to improve the Air Force's war requirements computation system. In this study, we extracted the LRU-SRU optimization logic from WARS and compared it to Dyna-METRIC logic. The Logistics Management Institute (LMI) also developed a methodology for determining the optimal LRU-SRU mix using a methodology similar to that used in the Aircraft Availability model now being implemented for computing peacetime requirements. This methodology was also compared to Dyna-METRIC and to the LRU-SRU optimization logic from WARS. The LMI model and the WARS model provide the same results. We choose to use the LMI approach because of its computational efficiency.

CHAPTER 2

ANALYSIS

We document our analysis in two sections. In the first section, we document our approach and findings. In the second section, we discuss implementation.

APPROACH AND FINDINGS

Using actual failure and repair data from the War Requirements Computation System (DO29), we compared the cost and stockage performance of four alternative Dyna-METRIC-based models for the F-15, F-4 and F-111 weapon systems. These three weapon systems use an RRR maintenance concept and, therefore, represent the potential requirements cost savings from optimizing the LRU and SRU indenture relationship.

Although we do not show the current system in this study, it is important to understand why Dyna-METRIC computes leaner, cheaper kits. The current DO29 system uses a marginal analysis approach that minimizes a weighted average of grounded aircraft and backorders. The current system does not consider indenture relationships; it treats all items as LRUs. Thus, if an SRU is not available, the weapon system is grounded even if its parent LRU is available. As a result, the current system does not optimize aircraft availability; it does not find the least cost collection of items to meet the aircraft availability target.

The Dyna-METRIC model is advertised to optimize aircraft availability. Technically, Dyna-METRIC minimizes the cost to meet a prespecified probability of having fewer than some prespecified (direct support objective) number of aircraft grounded. As we stated earlier, Dyna-METRIC accurately considers indenture relationships; however, it does not find the least cost mix of LRUs and SRUs to meet given weapon system availability. Strictly speaking, Dyna-METRIC starts with a given support level for the SRUs and then determines the minimum cost group of LRUs required to meet the weapon system objectives. So the kit's makeup depends on the starting SRU stockage position. In the current Weapon System Management Information System (WSMIS) Requirements Execution Availability Logistic Module (REALM) specifications, we initially planned to compute three separate kits with different starting SRU support levels and select the least cost option as the final WRSK requirement. We compute three initial SRU levels:

Model A: Dyna-METRIC with an SRU stock balance that achieves a 50 percent probability of meeting each SRU's demands;

Model B: Dyna-METRIC with an SRU stock balance that achieves a 67 percent probability of meeting each SRU's demands; and

Model C: Dyna-METRIC with an SRU stock balance that achieves an 84 percent probability of meeting each SRU's demands.

REALM then selects from the three separate runs, the kit that results in the least cost total (SRU plus LRU) requirement level.

Model D: Modified Dyna-METRIC is basically the Dyna-METRIC model except we add a routine that computes alternative mixes of an LRU and its associated SRUs. The routine selects the least cost mix of LRUs and SRUs that provides about the same end item LRU availability. We provide an illustration later to explain this more fully. The modified Dyna-METRIC uses the same demand probability distributions, the same average pipeline computations and the same marginal analysis logic as Dyna-METRIC. The only difference is an additional step which finds the least cost mix of spares to meet a given LRU availability target.

So now that we've described the models, we're ready to compare the costs, backorder and overall availability performance of the four models. For the Dyna-METRIC model (Models A through C), we show all three runs for comparison purposes. Recall, the least total cost run is the Dyna-METRIC computation we intend to use in REALM to compute WRSK requirements. Tables 2-1, 2-2, and 2-3 provide the results for the F-15, F-4 and F-111 respectively.

COMPARISON RESULTS
F-15 24PAA
(DSO = 6)

Model	Day 30 Grounded Aircraft	Confidence Level	30 Day Cumulative Backorders	Total Cost (\$ Mil)	LRU Cost (\$ Mil)	SRU Cost (\$ Mil)	Range Line Items	Depth Units
A. Dyna-METRIC SRU 50% Support	5.48	.80	167	26.7	23.7	3.0	325	1142
B. Dyna-METRIC SRU 67% Support	5.47	.81	168	26.5	22.4	4.1	370	1241
C. Dyna-METRIC SRU 84% Support	5.48	.83	169	26.2	20.9	5.3	417	1370
D. Modified Dyna-METRIC	5.48	.83	210	22.8	19.2	3.6	406	1351

Table 2-1

COMPARISON RESULTS
F-4 24PAA
(DSO = 6)

Model	Day 30 Grounded Aircraft	Confidence Level	30 Day Cumulative Backorders	Total Cost (\$ Mil)	LRU Cost (\$ Mil)	SRU Cost (\$ Mil)	Range Line Items	Depth Units
A. Dyna-METRIC SRU 50% Support	5.41	.80	157	61.3	60.9	.4	374	1208
B. Dyna-METRIC SRU 67% Support	5.42	.80	158	60.8	60.2	.6	420	1320
C. Dyna-METRIC SRU 84% Support	5.42	.80	158	60.5	59.6	.9	460	1468
D. Modified Dyna-METRIC	5.47	.80	183	59.7	58.6	1.1	443	1637

Table 2-2

COMPARISON RESULTS
F-111 18PAA
(DSO = 5)

Model	Day 30 Grounded Aircraft	Confidence Level	30 Day Cumulative Backorders	Total Cost (\$ Mil)	LRU Cost (\$ Mil)	SRU Cost (\$ Mil)	Range Line Items	Depth Units
A. Dyna-METRIC SRU 50% Support	4.58	.80	118.8	57.2	54.9	2.3	439	7098
B. Dyna-METRIC SRU 67% Support	4.60	.80	121.2	54.9	51.7	3.2	470	7147
C. Dyna-METRIC SRU 84% Support	4.55	.81	120.2	54.2	49.9	4.3	489	7204
D. Modified Dyna-METRIC	4.64	.80	143.0	51.0	45.9	5.1	463	7281

Table 2-3

As a point of comparison, the current War Requirements Computation System (DO29) cost for the F-15 kit shown in Table 2-1 is \$44.5 Million. The least cost Dyna-METRIC F-15 kit is Method C, which results in an \$18.3 Million (\$45.5 - \$26.2) requirement cost reduction compared to the current DO29 System. The Modified Dyna-METRIC (Method D), which finds the least cost mix of LRUs and SRUs, reduces the requirement cost another \$3.4 million (\$26.2 - \$22.8) for the F-15 kit.

Note from Tables 2-1 through 2-3 that, in general, the Modified Dyna-METRIC (Method D) model stocks more SRUs and reduces the stock of LRUs. This optimization technique tends to stock more component parts, which reduces the awaiting parts times for the LRUs, thereby reducing the need for LRUs. To illustrate, Tables 2-4 and 2-5 provide examples of the LRU-SRU tradeoffs for two F-15 LRUs.

LRU-SRU OPTIMIZATION
EXAMPLE ONE
(LRU 5841010505979)

LRU-SRU	Unit Cost (\$)	Average Demand	Dyna-METRIC Stock Level	Dyna-METRIC Stockage Cost (\$)	Modified Dyna-METRIC Stock Level	Modified Dyna-METRIC Stockage Cost (\$)
LRU	68,756	2.289	3	206,267	2	137,511
SRU	10,825	.760	1	10,825	2	21,651
SRU	22,589	1.658	1	22,589	2	45,178
SRU	7,829	.998	1	7,829	2	15,658
SRU	23,930	1.064	1	23,930	1	23,930
SRU	11,413	1.825	2	11,413	3	34,239
Total Cost				294,266		278,167
Resulting LRU Availability				.99408		.99462

Table 2-4

Table 2-4 shows the requirement cost savings possible from stocking additional SRUs and reducing the LRU level by one unit. Note the resulting LRU availability is the same at reduced cost.

LRU-SRU OPTIMIZATION
EXAMPLE TWO
(LRU 6605010940775)

LRU-SRU	Unit Cost (\$)	Average Demand	Dyna-METRIC Stock Level	Stockage Cost (\$)	Modified Dyna-METRIC Stock Level	Stockage Cost (\$)
LRU	22,544	4.441	6	135,262	5	112,718
SRU	1,981	.189	0	0	1	1,981
SRU	1,245	.194	0	0	1	1,245
SRU	663	.208	0	0	2	1,327
SRU	6,616	.312	0	0	1	6,616
Total Cost				135,262		123,987
Resulting LRU Availability			.99749		.99751	

Table 2-5

Table 2-5 provides an example where deciding to stock low priced SRU reduces the need for one LRU, thereby reducing the requirement cost. Thus, although any one SRU will probably not generate six demands, the Modified Dyna-METRIC stocks them because they reduce the number of LRUs required to be stocked. The point is just because an SRU may not generate six or more demands, its contribution to reducing its parent LRU awaiting parts time may still warrant its stockage. Therefore, deleting items with stock levels of 1 or 2 from the kit may needlessly increase the cost of the kit.

The Modified Dyna-METRIC model will provide equal support at reduced cost by determining the least cost mix of LRUs and SRUs necessary to meet the direct support objective. Table 2-6 identifies the Air Force-wide REQUIREMENTS cost savings from implementing the Modified Dyna-METRIC model. We emphasize the word requirements, because implementing the Modified Dyna-METRIC model may not reduce the buy cost immediately. If the Modified Dyna-METRIC model reduces the requirement for an item that is currently available or on order, there is no war readiness cost savings. It is likely most items are currently available; however as new weapon systems and modifications to existing weapon systems occur in the future, reducing requirements will reduce war readiness buy costs. In addition, reducing the war readiness requirement may free up units to satisfy Peacetime Operating Stock (POS) and Other War Reserve Materiel (OWRM) requirements. So reducing the war requirement may reduce the POS and OWRM buy requirement cost.

MODIFIED DYNA-METRIC PROJECTED REQUIREMENTS COST REDUCTION

Weapon System	Projected Number of Generic Kits	Requirement Cost Savings Per Kit (\$)	Total Requirements Cost Savings Weapon System (\$)
F-15	10.3	\$3.46M	\$35.64M
F-4	21.8	\$.76M	\$16.57M
F-111	4.3	\$3.24M	\$13.93M
Total			\$66.14M

Table 2-6

Implementing the Modified Dyna-METRIC model will result in an Air Force wide requirements cost decrease of \$66 million. This \$66 million is in addition to the projected requirement cost decrease resulting from replacing the current war requirement computational algorithm (DO29) with Dyna-METRIC [1].

IMPLEMENTATION

AFLC currently plans to implement Dyna-METRIC to compute WRSK requirements as part of WSMIS/REALM. AFLC will use Dyna-METRIC to compute the F-15, F-111, and F-16 buy kits and the F-16 contingency kit in March 1988. After March 1988, Dyna-METRIC will also be used to compute each weapon system after their WRSK review. Thus, Dyna-METRIC is the Air Force's war readiness requirements computational model.

As a result of this analysis, we are currently working with the WSMIS contractor, the Dynamics Research Corporation, to include the modified Dyna-METRIC model as part of WSMIS/REALM. We have a working prototype already developed. The new modified model is still Dyna-METRIC; the resulting kits still provide an 80 percent probability of having fewer than 6 (out of 24) aircraft grounded. If we are able to adequately test the model within WSMIS/REALM, we intend to begin using the Modified Dyna-METRIC by May 1988. The Modified Dyna-METRIC also has the capability to compute requirements to maximize aircraft availability with a funding cap. WSMIS/REALM needs the limited funds requirements computation methodology to determine what wartime spares to buy with limited funds. AFLC expects to compute limited funding WRSK requirements in the summer of 1988.

Subsequent to our study, HQ TAC conducted some analysis on their F-15 WRSK and questioned the wisdom of computing kits with an SRU stock balance that achieves a 50 percent probability of meeting each SRU's demands. They felt limiting the stockage of SRUs unnecessarily limits repair capabilities, which is the major advantage of RRR kits. In virtually all of our WRSK computations (for example see Table 2-1 through 2-3), the

least cost stockage option was the one that stocked SRUs that achieved an 84 percent probability of meeting each SRU's demands. TAC believes SRUs should be stocked to achieve an 80 percent probability of meeting each SRU's demands. Since almost all of our runs showed around 80 percent was the least cost option and since there is relatively little cost difference between the three SRU stockage options, we agreed to change our initial plans for SRU stockage to implement REALM. Until we implement the modified Dyna-METRIC model, REALM will still compute three SRU stockage options and select the lowest cost option. However, the three SRU stockage options will stock SRUs to achieve a 80 percent, 85 percent and 90 percent probability of meeting SRU demands. We will use these three SRU stockage options upon implementation of REALM in March 1988, and continue to use them until we implement the modified Dyna-METRIC model.

CHAPTER 3

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The Dyna-METRIC model computes War Readiness Spares Kits (WRSKs) that provide the same combat capability as the current War Requirements Computation System (DO29) but at reduced cost.
2. Although Dyna-METRIC accurately considers indenture relationships, it does not compute the lowest cost mix of line replaceable units (LRUs) and shop replaceable units (SRUs).
3. The Modified Dyna-METRIC model computes the lowest cost mix of LRUs and SRUs, thereby reducing the Air Force's requirements cost from \$.76 to \$3.46 million per repair, remove and replace (RRR) kit.
4. The Modified Dyna-METRIC model should be included in the Weapon System Management Information System (WSMIS) Requirements Execution Availability Logistics Module (REALM) because it computes kits that provide the same combat capability at even less cost than (the unmodified) Dyna-METRIC and it computes the spares needed to maximize aircraft availability with limited funds.
5. Until the modified Dyna-METRIC model is implemented, REALM will compute WRSK using the least cost of three Dyna-METRIC computations. The three options will be to compute SRUs to achieve an 80, 85 and 90 percent probability of meeting each SRU's demands.
6. The WSMIS contractor, Dynamics Research Corporation, is currently implementing the modified Dyna-METRIC model into REALM in order to compute Air Force WRSK requirements and to maximize combat capability with limited war spares funding by May 1988.

Recommendations

1. Implement the Modified Dyna-METRIC model within WSMIS/REALM. (OPR: HQ AFLC/MMM and LMSC/SMW)
2. Use the Modified Dyna-METRIC model to compute both full funding and limited funding Air Force WRSK requirements. (OPR: HQ AFLC/MMM)

REFERENCES

1. Blazer, Doug Lt. Col., and Professor Doug Rippy, "Using Dyna-METRIC to Compute War Readiness Spares Kit Requirements", AFLC Material Analysis Technical Report, August 1987.

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