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LDEF GEOMETRY/MASS MODEL FOR RADIATION ANALYSES*

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SUMMARY

A three-dimensional geometry/mass model of LDEF is under development for ionizing radiation analyses. This model, together with ray-tracing algorithms, is being programmed for use both as a stand-alone code in determining 3-D shielding distributions at dosimetry locations and as a geometry module that can be interfaced with radiation transport codes.

INTRODUCTION

To aid in the interpretation of ionizing radiation dosimetry data, and to obtain more accurate comparisons of dosimetry measurements with model predictions, a three-dimensional geometry/mass model of the Long Duration Exposure Facility (LDEF) satellite is under development. The modeling approach and level of detail being incorporated is described below.

APPROACH

Three general categories of LDEF components are defined for modeling purposes (fig. 1). The major structural components of the spacecraft are being modeled individually, as illustrated in fig. 2. The mass of other components of the spacecraft ("miscellaneous" category of fig. 1, which amounts to about 5% of the total mass) is combined with the mass of the larger components, except that the thermal covers are modeled individually. The third category is the experiment trays, containing the tray itself and the contents of the experiment. Since the weight of individual experiments varies substantially (fig. 3), each of the 84 experiment trays is modeled separately.

For experiment trays containing radiation dosimetry, "detailed" modeling of major components within the tray is being performed so that local shielding variations in the vicinity of the dosimeters can be accounted for (fig. 4). For trays not containing ionizing radiation dosimeters, only the volume and mass of the trays are preserved. The contents of these "generic" trays are modeled as homogeneous aluminum of reduced density.

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Input data for the model is based on information provided by the LDEF Project Office (J. Jones) and others at LaRC (R. Shearer), including engineering drawings of the spacecraft and pre-flight weight estimates and layouts of individual experiments, and information on component layouts and materials descriptions obtained from individual experimenters.

The combinatorial geometry methodology is being used. In this method Boolean logic is applied to combine descriptions of simple body shapes to simulate complex geometries.

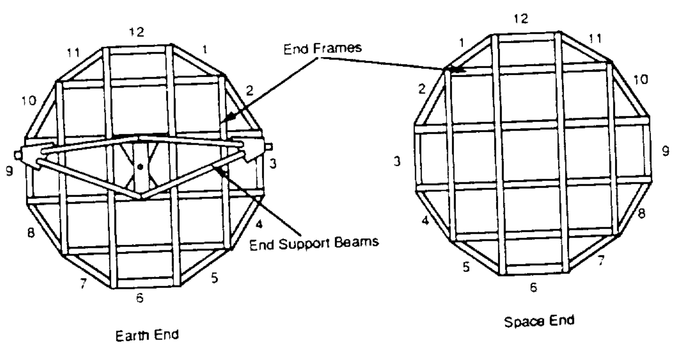
The model is being programmed to allow operation in either of two modes: as a geometry module which can be interfaced with radiation transport codes, and as a stand-alone program with ray tracing (fig. 5). In this latter mode, the areal density and material composition along rays emanating from specified points can be computed to form a 3-D grid of shielding variations about the point. For dosimeters where individual particle tracks are measured, this ray-tracing mode will allow rays to be started that have directions corresponding to the track direction, so the material traversed in reaching the dosimeter can be estimated for individual tracks.

STATUS

At present the LDEF spacecraft structure with generic experiment trays has been modeled. Detailed modeling for several of the trays containing ionizing radiation dosimeters (Experiments P0004, P0006, and M0004) is in progress.

Category	Component	No. Places	Weight (lbs.)	Weight %	Modeling Approach
STRUCTURE	Center Ring	1	2,073	9.7%	Modeled as individual component.
	Longerons	24	2,280	10.7%	Modeled as individual components.
	End Frames	2	1,374	6.4%	Modeled as individual components.
	Diagonal Tubes	8	926	4.3%	Modeled as individual components.
	Intercostal Rings	72	758	3.5%	Modeled as individual components.
	Trunions,Pins, & Scuff Plates	10	501	2.3%	Modeled as individual components.
	End Support Beams	5	285	1.3%	Modeled as individual components.
	TOTAL STRUCTURE:		8,197	38.3%	
MISCELLANEOUS	Batteries	2	100	0.5%	Included as part of earth-end support beam weight.
	Initiate Electronics	1	105	0.5%	Included as part of center ring weight.
	Wiring	-	100	0.5%	Included as part of center ring weight.
	Nuts and Bolts	-	200	0.9%	Included as part of center ring weight.
	Damper Assembly	1	62	0.3%	Included as part of space-end support beam weight.
	Thermal Covers (Ends)	12	154	0.7%	Modeled as individual components.
	Ballast Plates	11	365	1.7%	Included as part of end frames.
	TOTAL MISCELLANEOUS:		1,086	5.1%	
EXPERIMENTS	Experiment Components + Trays	84	12,110	56.6%	Modeled each experiment tray separately, with individual experiment weights preserved. Modeling detail for components varies with experiment type.
	TOTAL LDEF WEIGHT:		21,393	100.0%	

Fig. 1. Level of detail incorporated in LDEF geometry/mass model.



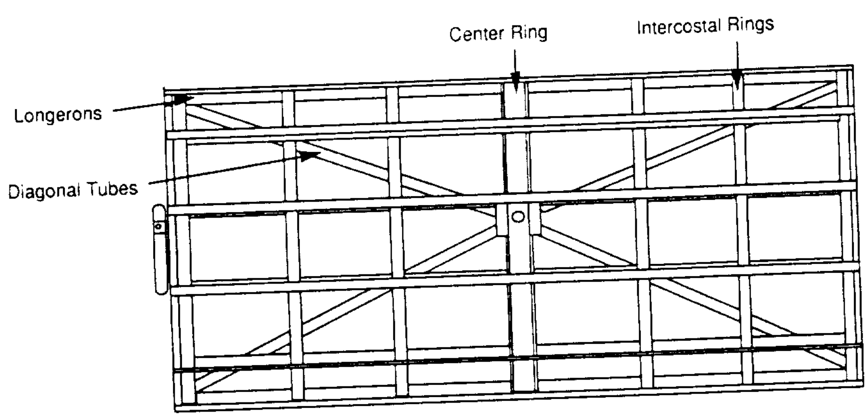


Fig. 2. Model of LDEF spacecraft structure.

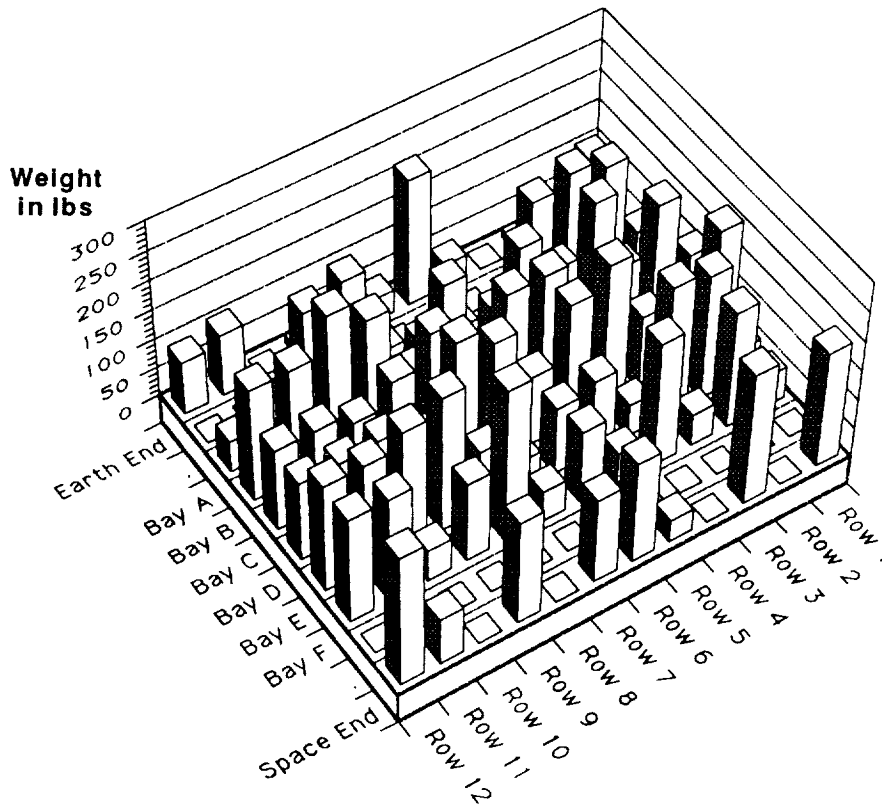
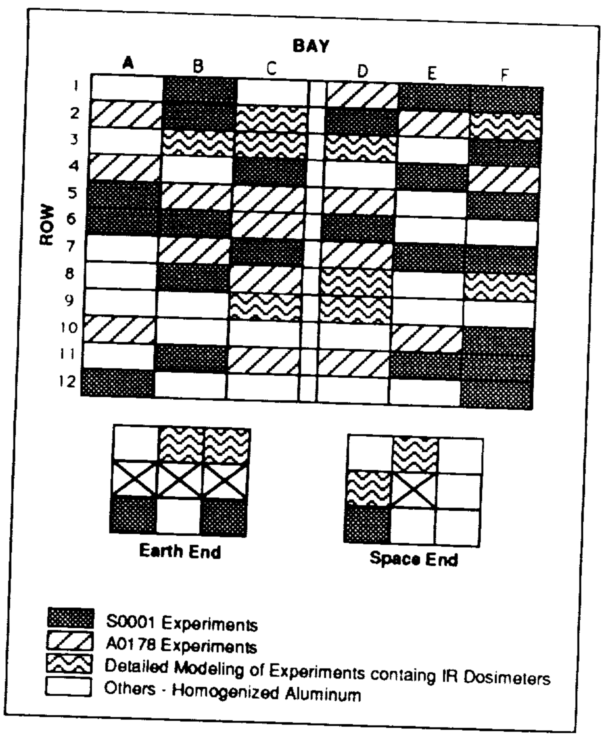


Fig. 3. Weights of individual experiments on LDEF.



Level of Detail for Modeling Experiments:

No. Trays	Model	Experiments
26	Al plate	S0001: Space Debris (LaRC)
16	Al+plastic plates	A0178: Ultra-heavy Cosmic-Ray Expt. (Dublin Inst., ESTEC)
13	"detailed"	Experiments containing IR dosimetry - see NOTE
29	homogenized Al	(all others)

NOTE: Trays Containing IR Dosimetery for Detailed Modeling are:

Tray Bay-Row	Experiment No.	Experiment	Dosimetry
C-2, G-2	A-0015	Biostack (DFVLR)	TLD's, PNTD's
C-3, C-9	A-0114	Atomic Oxygen (UAH, MSFC)	Activation Samples
B-3	A-0138	Optical Fibers (CERT/ONERA - DERTS)	TLD'S
H-3, H-12	M0001	Heavy Ions (NRL)	PNTD's
D-3,D-9,G-12	M0002-1	Trapped Proton Spect. (AFGPL,MSFC, et al.)	PNTD's,TLD's,Act.
E-6	M0002-2	Heavy Cosmic-Ray Nuclei (U. Keil)	PNTD's
D-3,D-8,D-9	M0003	Space Envr. Effects on Matls. (Aerospace)	TLD's
F-8	M0004	Space Envr. Effects on Optics (AFWL)	TLD's, PNTD's
C-2	M0006	Space Envr. Effects (AFTAC, Grumman)	TLD's
F-2	P0004	SEEDS	TLD's, PNTD's
F-2	P0006	LET Spectrum Meas. (Univ. SF, MSFC)	TLD's, PNTD's, Fiss. & Act. Samples

Fig. 4. Modeling approach for LDEF experiments.

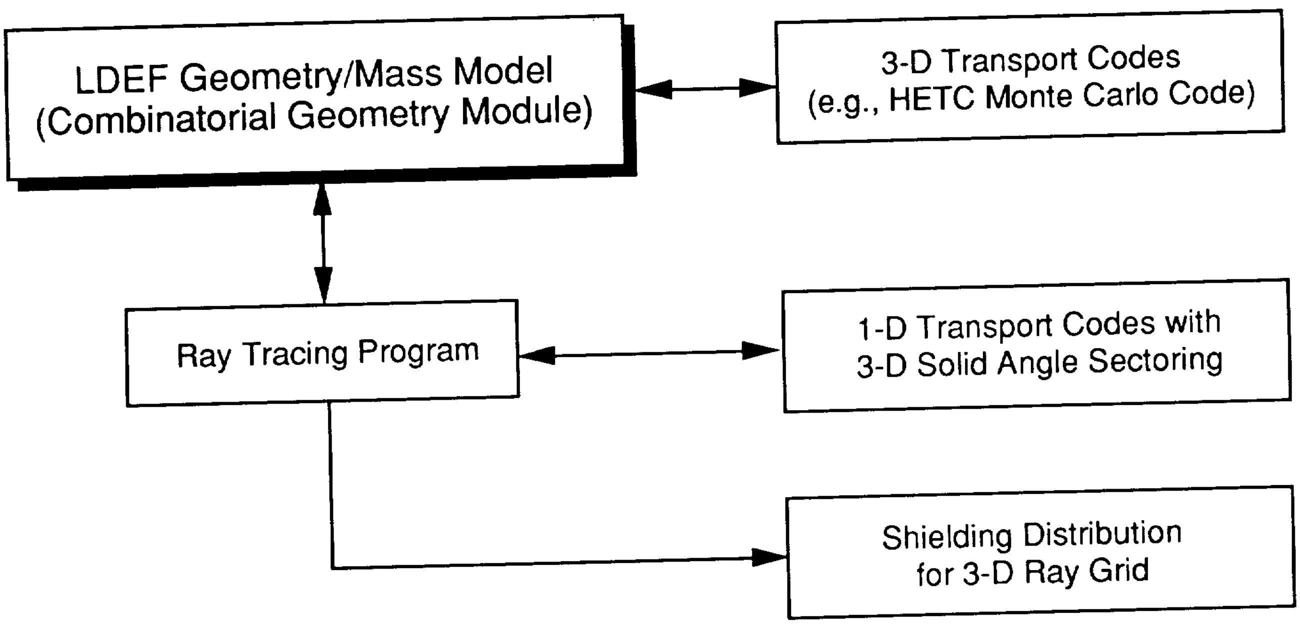


Fig. 5. Utility of LDEF geometry/mass model.