MEEINC More Dimensions. More Profits.



A 3-Market, I 0-Dimension Trade Doug Howarth, CEO, MEE Inc. dhowarth@meevaluators.com

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"Man's mind, stretched by a new idea, never goes back to its original dimensions."

Presented for the International Cost Estimating & Analysis Association Otiver Wendell Holmes, Jr.





- A new way to solve long-standing problems
- Problem to solve
- Analyzing related markets
- Putting it together
- Conclusion



di men sion (dĭ-mĕn'shən, dī-) n.

I.A measure of spatial extent, especially width, height, or length.

4. Mathematics

a. The least number of independent coordinates required to specify uniquely the points in a space.b. The range of such a coordinate.

We'll be studying economic (mathematical) dimensions

Which Two Countries Are These?



Where do they touch?

Why is this important?

They Touch At The South Pole



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What if instead of denoting the South Pole 90° we call it 0?

Every step away from it is positive.

How can we use this?

Opposing, nonnegative systems are key to widening viewpoints



Multiple Market Problem: What Kind Of MEE



When it absolutely, positively must be there in an hour: What features should a Prompt Global Strike missile have?

What Missiles Do We Have Now?



						Pay-		Max
				2016	Launch	load	Max	Range
Туре	Number	Name	Quantity	Price	Kg	Kg	V kph	Km
Glide Bomb	BLU-109	2000 lb	18,556	\$51,000	924	240	1,605	28
Glide Bomb	BLU-110	1000 lb	6,565	\$36,000	447	202	I,605	28
Glide Bomb	BLU-111	500 lb	33,330	\$32,000	227	87	I,605	28
Glide Bomb	BLU-117	2000 lb	24,506	\$40,000	948	429	I,605	28
Glide Bomb	SBD I	Sml Dia Bmb	۱6,577	\$59,000	129	93	1,200	
Glide Bomb	SBD II	Sml Dia Bmb	2,417	\$78,000	129	93	1,200	72
Missile	AGM-158	JASSM	635	\$1,352,000	1,021	450	1,200	370
Missile	AGM-158-1	JASSM-ER	275	\$1,912,000	1,021	450	1,200	٥٥٥, ١
Missile	AGM-88E	HARM	643	\$892,000	355	66	2,280	١50
Missile	AGM-84	SLAM-ER	4,152	\$528,000	675	221	855	270
Missile	AGM-130	Powered GBU-15	102	\$804,000	1,323	907	1,200	75
Missile	AGM-154A	USAF JSOW Soft	I,742	\$557,000	450	42	1,200	110
Missile	AGM-154B	USAF JSOW Vhcls	3,893	\$501,000	450	177	1,200	110
Missile	AGM-154C	USN Hard Target	6,599	\$442,000	450	250	1,200	110
Missile	AGM-142	Have Nap	46	\$1,773,000	1,361	350	I,482	80
Missile	AGM-114P	USAF Hellfire	14,886	\$113,000	47	9	1,591	8
Missile	AGM-114N	USN Hellfire	8,741	\$123,000	47	9	1,591	8
Missile	AGM-114R	US Army Hellfire	25,238	\$161,000	47	9	1,591	8

Air-To-Surface Demand Frontier





Air-To-Surface Value (Where Value = Sustainable Price, Based On Purchases)

Price =977 *R Km^{0.452} * Grv1,Pow2^{3.00} * MV^{0.167}

Where: Price = estimated 2016\$ RKm = range in kilometers GrvI, Pow2 = gravity bombs I, missiles 2

MV = mass * max Kph (momentum)

Value **Missiles** \$106 Prices Glide Bombs \$105 \$104 Presented for the International Cost Estimating & Analysis Association (know www.iceaaonline.com

Knowing what the missiles can do is key to their utilization

Consider Value And Demand At The Same Time Across 4 Dimensions





What Bombers Do We Have Now?



Aircraft	1957- 2016 Quantity	2016 Flyaway \$	Max Kph	Payload Kgs	Range (Km)	Aircraft	1957- 2016 Quantity	2016 Flyaway \$	Max Kph	Payload Kgs	Range (Km)
B-52	740	\$80,200,000	1046	36287	16327	A-10	716	\$19,600,000	707	7257	4152
B-1B	100	\$424,600,000	1336	56699	11999	F-14	712	\$57,100,000	2485	6577	2961
AV-8B	323	\$42,400,000	1064	6003	1101	F-111	563	\$106,000,000	2655	14288	6759
F/A-18A-D	1480	\$50,900,000	1915	6337	2012	F-4	5195	\$18,700,000	2369	8459	2599
F/A-18E/F	563	\$64,900,000	1915	8051	2443	A-7	1569	\$13,300,000	1123	6804	4603
F-15A-E	1415	\$51,600,000	3018	11113	2543	F-8	1219	\$11,900,000	1971	1814	2792
F-117A	64	\$85,300,000	993	1814	1721	A-4	2960	\$7,200,000	1083	4491	3219
F-16C/D	4540	\$28,200,000	2128	7711	4216	F-5	2246	\$9,700,000	1706	3175	3718
F-22	195	\$171,900,000	2414	9539	2961	F-35A	177	\$177,300,000	1713	8165	2221
B-2	21	\$1,143,400,000	1014	22680	11104	F-35B	36	\$185,000,000	1712	6804	1666
A-6	693	\$64,600,000	1043	8165	5222	F-35C	63	\$221,900,000	1712	8165	2221

The data changes with every delivery

Bomber Demand Frontier Is Little Changed For The Last 20+Years





A Highly-Correlated Demand Frontier Has Implications For The B-21 Bomber

There is little chance the B-21 program will hit its Quantity-Price target

This scenario's chance

is << | in |B



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The Quantity Term Reveals A Product Demand Curve



Price = 45703Qty^{-0.664} *PL Kgs^{0.659} *Max Kph^{0.737}

<u>Where:</u> Price = aircraft price, in 2016\$ Qty = aircraft sold, 1957-2016 PL Kgs = max payload kilograms Max Kph = max kilometers/hour

If data reveals a Product Demand Curve, it should always be compared to its Demand Frontier



We Can Also Use The Value Equation To MEE



Tanker Database Is Small



Maker and Model	Total Q	NATO Active Q	2019\$M	1st Yr	Op yrs	MxPLlbs	R nm	MxMPH	Engs
Lockheed HC-130	75	45	\$83.28	1959	61	36500	1050	380	4
McDonnell Douglas KC-10	62	59	\$139.57	1981	39	356000	3826	619	3
Lockheed Martin KC-130B	6	6	\$76.78	1958	62	45000	1000	362	4
Lockheed Martin KC-130H	33	33	\$76.78	1965	55	45000	1000	362	4
Lockheed Martin KC-130T	28	28	\$76.78	1983	37	45000	1000	362	4
Lockheed Martin KC-130J	53	53	\$76.74	2004	16	57000	2835	417	4
Boeing KC-135	803	398	\$62.52	1957	63	150000	1304	580	4
Boeing F/A-18E/F	600	120	\$74.07	2001	19	13040	390	1190	2
Bell Boeing CMV-22B	39	1	\$79.18	2007	13	10000	390	351	2
Airbus A310 MRTT	6	6	\$134.40	2009	11	62000	972	608	2
Airbus A330 MRTT	39	41	\$253.43	2011	9	143000	972	547	2
Airbus A400M Atlas	87	87	\$184.93	2013	7	111300	1800	485	4

The database is small, but we must work with what we have

We Find Tanker Value Correlates Well, But Demand Does Not



A 7D View





Data Compression Lets Us See More Dimensions: Consider These GA Planes



This looks like an extended Cartesian system; orthogonality is a default condition

Demand Curve Data Has No Angularity Requirements To Value Space, Thus...



We do not lose the Demand information if we drop orthogonality Presented for the International Cost Estimating & Analysis Association - www.iceaaonline.com

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We Swing The Demand Plane Further





And Further...





And Further...





Until We Collapse It Against Value Space





We have not lost Demand data by moving the Demand Plane

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In Order To Compress Value Space, We Use Some Analytical Geometry



We have the Base 10 Logs of Features 1 & 2

We Take their Polar Coordinates as we Adjust Angle from 90°

Importantly, we can Return to 90°

Log-Polar Systems convert to Log-Cartesian & vice versa

Value data compression offers more analytic space



Why not have a Multiple MarketView **Looking Down from Above?**



I O³

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Multiple Dual-Axis Polar-Log Coordinates Start with a one market Adjust to market size Add more markets Green circle is GDP **10**² 10-1 100 101 N markets – no limit Value Space Planes angle is that market's portion of GDP, the Demand Plane of each market abut one of

those Value Plate for the International Cest Estimating Analysis Association Awawa iseaaonline.com Angle 2 = 70 ° Angle 4 =

A 3-Market, I0D View

MEE

Each market's upper extent is its costliest

Each market's lower end is its least expensive

The outer edge of each plane represents its maximum value

The angle between the Value Planes represents that market's part of GDP

This view offers a way to compare multiple markets at the same time



A 5-Market, I6D View Of Other Markets



To plot N markets, we need 3n+1 dimensions

This view represents about 3% of GDP



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PGS Has I Hr Reqmt., Tankers Are Out; We Must Trade Bombers & Missiles



Subsonic bomber gets missile to launch height, hypersonic missile covers most of the distance

More, less expensive B-21s could offer more starting bases; B-2 and B-52 could help

Using Air-to-Surface missiles is an extrapolation for PGS, must study existing hypersonics

These techniques quantify the trades governments, businesses, and people make Presented for the International Cost Estimating & Analysis Association - www.iceaaonline.com

Summary And Conclusions



- Market does not support 100 B-21s at \$610M in 2016\$
- Positioning more aircraft closer to more targets enables more successful PGS missions
- Hypersonic air-to-ground missiles are an extrapolation
- Many projects involve more than one market
- Related markets should coordinate with each other
- To address n markets, we need 3n+1 dimensions

You have been doing these trades already, these methods quantify them and reveal what you can and cannot do

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