

# Convenience of Matrix Functions

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# Abstract

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- ▶ This presentation will **define matrices** and **explain** each of the **functions available** within ACE. It will also **demonstrate** with specific examples how **matrix functions** save time and row space **in estimates**.

# Agenda

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- ▶ Definition
- ▶ Purpose
- ▶ Functions available
- ▶ My perspective
- ▶ Examples
  - ▶ schedules
  - ▶ personnel costs
- ▶ Summary

# Define

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- ▶ A matrix is a set of numbers laid out in tabular form<sup>1</sup>
- ▶ Laid out in Yearly Phasing Workscreen<sup>1</sup>
- ▶ Two different types<sup>1</sup>:
  - ▶ Year dependent (e.g., Buy Quantity)
  - ▶ Non-year dependent (e.g., component configuration data)

# Purpose

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- ▶ Using matrices...
  - ▶ saves rows
  - ▶ decreases number of Unique IDs
  - ▶ saves time<sup>2</sup>
    - ▶ flexible, data is easily modified
    - ▶ scalable, easy to increase/decrease the size of matrix
    - ▶ repeatable, can use same equation on multiple rows
  - ▶ organizes data

# Matrix Functions in ACE<sup>3</sup>

Function Name	Description
MatColCol( Num_Rows, @FiscalYr_Matrix, @Constant_Matrix, Col )	Multiply two columns of equal length together.
MatColRow( N_Rows, @Quantity, @Config, Row )	Multiply a column by a row of equal dimension.
MatColTot( N_Rows, @Vector, @Matrix, Col )	Multiply a column times a column of estimate totals. Both are of equal dimension.
MatTotTot( N_Rows, @Vector1, @Vector2, ...)	Multiply two columns of estimate totals of equal length together.
MatColDot( Num_Rows, Index1, @Var1, Index2, @Var2, ... )	Multiply a user specified number of columns of equal length together.
MatDecVal( @Matrix, Index, @DECId )	Select a value from a given DEC row in a matrix.
MatDot( N_Rows, Type1, Index1, @Var1, Type2, Index2, @Var2, ...)	Multiply a user specified number of rows or columns together.
MatVal( @Matrix, Row, Col )	Select a value from a given location in a matrix.

# Matrix Functions in ACE<sup>4</sup>

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<b>Multiply Vectors</b>	<b>Multiply FY columns by a Single Column or Row</b>	<b>Multiply More than 2 Row/Column Combinations</b>
MatTotTot()	MatColCol()	MatColDot()
MatColTot()	MatColRow()	MatDot()

# My Perspective

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- ▶ Cost and Systems Analysis Office
- ▶ Typically Acquisition Category (ACAT) III programs
  - ▶ <\$140M RDTE or <\$660M Proc
- ▶ Certain estimating/info gathering methods repeat from program to program
- ▶ Advanced ACE modeler; Novice matrix functions
- ▶ Fantastic functions, increase capability tremendously



# Examples

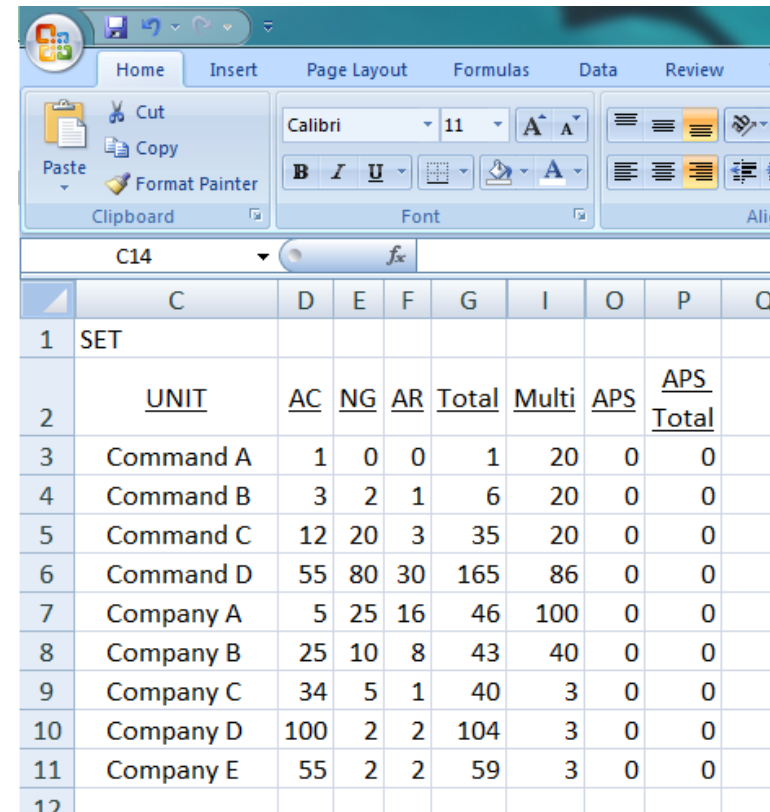
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- ▶ **Schedule Example of a Set**
  - ▶ `MatColTot( N_Rows, @Vector, @Matrix, Col)`
  
- ▶ **Military Personnel Costs Example of an Outfit**
  - ▶ `MatVal( @Matrix, Row, Col )`

# Schedule Example

## ▶ Set Schedule

- ▶ PM Provides excel table format with a multiplier that determines the qty per unit
  - ▶ Fed by the Combat Developer based on their mission and unit requirements, where the multiplier may be different in each unit's case.
- ▶ CPD → Excel → ACE
- ▶ Non-year associated



	C	D	E	F	G	I	O	P	Q
1	SET								
2	<u>UNIT</u>	<u>AC</u>	<u>NG</u>	<u>AR</u>	<u>Total</u>	<u>Multi</u>	<u>APS</u>	<u>APS</u> <u>Total</u>	
3	Command A	1	0	0	1	20	0	0	
4	Command B	3	2	1	6	20	0	0	
5	Command C	12	20	3	35	20	0	0	
6	Command D	55	80	30	165	86	0	0	
7	Company A	5	25	16	46	100	0	0	
8	Company B	25	10	8	43	40	0	0	
9	Company C	34	5	1	40	3	0	0	
10	Company D	100	2	2	104	3	0	0	
11	Company E	55	2	2	59	3	0	0	
12									

# Schedule Example

- ▶ **MatColTot( N\_Rows, @Vector, @Matrix, Col)**
  - ▶ This function performs a vector multiplication for a column by column calculation. It returns the product of a column vector with a column in another matrix.

Set - Schedules.aceit - Yearly Phasing (BY2012\$M)							Schedules.aceit - Methodology (BY2012\$M)						
	WBS/CES Description	Phasing Method	Unique ID	FY 2012	FY 2013	FY 2014	WBS/CES Description	Category	Unique ID	Point Estimate	Phasing	Equation / Throughput	FY
372	*MATRICIES			Active	NG	AR	*MULTIPLIER						
373	Set Distribution		Set_Matrix				Set	Set_Vector	*		[Multiplier]		
374	Command A	I		1	0	0	Command A		20 *	C	20		
375	Command B	I		3	2	1	Command B		20 *	C	20		
376	Command C	I		12	20	3	Command C		20 *	C	20		
377	Command D	I		55	80	30	Command D		86 *	C	86		
378	Company A	I		5	25	16	Company A		100 *	C	100		
379	Company B	I		25	10	8	Company B		40 *	C	40		
380	Company C	I		34	5	1	Company C		3 *	C	3		
381	Company D	I		100	2	2	Company D		3 *	C	3		
382	Company E	I		55	2	2	Company E		3 *	C	3		

# Schedule Example

Set - Schedules.aceit - Methodology (BY2012\$M)

	WBS/CES Description	Appr op	Unique ID	Point Estimate	Phasing Met	Equation / Throughput
<b>332</b>	<b>*QUANTITIES FROM MATRICIES</b>					
333	Set- Total			33,031.000 *		
334	Set-Active		Set_Active_Qty	7,117 *	C	MATCOLTOT(9, @Set_Vector, @Set_Matrix, 1)
335	Set-National Guard		Set_NG_Qty	10,247 *	C	MATCOLTOT(9, @Set_Vector, @Set_Matrix, 2)
336	Set-Army Reserve		Set_AR_Qty	4,595 *	C	MATCOLTOT(9, @Set_Vector, @Set_Matrix, 3)
337						

Methodology \ Yearly Phasing \ All Columns /

Set - Schedules.aceit - Yearly Phasing (BY2012\$M)

	WBS/CES Description	Phasing Metho	Unique ID	FY 2012	FY 2013	FY 2014
<b>372</b>	<b>*MATRICIES</b>			Active	NG	AR
373	Set Distribution		Set_Matrix			
374	Command A	I		1	0	0
375	Command B	I		3	2	1
376	Command C	I		12	20	3
377	Command D	I		55	80	30
378	Company A	I		5	25	16
379	Company B	I		25	10	8
380	Company C	I		34	5	1
381	Company D	I		100	2	2
382	Company E	I		55	2	2

Methodology \ Yearly Phasing \ All Columns /

Schedules.aceit - Methodology (BY2012\$M)

	WBS/CES Description	Unique ID	Point Estimate	Phasing	Equation / Throughput
<b>7</b>	<b>*MULTIPLIER</b>				
8	Set	Set_Vector	*		[Multiplier]
9	Command A		20 *	C	20
0	Command B		20 *	C	20
1	Command C		20 *	C	20
2	Command D		86 *	C	86
3	Company A		100 *	C	100
4	Company B		40 *	C	40
5	Company C		3 *	C	3
6	Company D		3 *	C	3
7	Company E		3 *	C	3

Methodology \ Yearly Phasing \ All Columns /

# Schedule Example

Set - Schedules.aceit - Methodology (BY2012SM)						
	WBS/CES Description	Unique ID	Point Estimate	Phasing	Equation / Throughput	Fiscal Year
253	*Quantity Inputs	*QtyInputs				
254						
255	*PRODUCTION SCHEDULES					
256	ProSch Set-Total	ProSch_Set_Total	21,959 *			
257	ProSch Set-Active	ProSch_Set_Active	7,117 *	%	Set_Active_Qty	
258	ProSch Set-National Guard	ProSch_Set_NG	10,247 *	%	Set_NG_Qty	
259	ProSch Set-Army Reserve	ProSch_Set_AR	4,595 *	%	Set_AR_Qty	
260						

Set - Yearly Phasing (BY2012SM)						
CES Description	Phasing Method	Unique ID	FY 2012	FY 2013	FY 2014	FY 2015
*Quantity Inputs		*QtyInputs				
*PRODUCTION SCHEDULES						
Set-Total		ProSch_Set_Total				
Set-Active	%	ProSch_Set_Active			100	
Set-National Guard	%	ProSch_Set_NG			100	
Set-Army Reserve	%	ProSch_Set_AR			100	

- ▶ Turn the Qty Into a Production Schedule
  - ▶ Non-year associated equation into production schedule
  - ▶ Set was small enough to purchase several thousand in one year

# Military Personnel Cost Example

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- ▶ **MatVal( @Matrix, Row, Column)**
  - ▶ This function returns a value from a given location in a matrix.
- ▶ **Program uses an average of Military Occupational Specialty (MOS) costs**
  - ▶ multiple users, unspecified distribution
  - ▶ Army Military-Civilian Cost System (AMCOS)

# Military Personnel Cost Example

Outfits Personnel.aceit - Yearly Phasing (BY2012\$M)						
	WBS/CES Description	Phasing	Unique ID	FY 2012	FY 2013	FY 2014
626	*MP Inputs					
627	*AMCOS MP Inputs (Avg)			Active	NG	AR
628	31B		MilPers_31B			
629	Pay and Allowances	I		75000	10000	8000
630	MPA Training	I		1500	1000	1200
631	PCS	I		4000		
632	OMA & Other	I		5000	2000	1000
633	31D		MilPers_31D			
634	Pay and Allowances	I		90000	12000	10000
635	MPA Training	I		5000	100	100
636	PCS	I		4000		
637	OMA & Other	I		16000	100	150
638	311A		MilPers_311A			

- ▶  $(\text{Avg}(\text{MatVal}(\text{@Matrix}, \text{Row}, \text{Column})) * \text{AMCOS correction} * \text{TYtoBY} * \text{ManYear} * \text{OperSch})$ 
  - ▶ AMCOS Correction- \$ units
  - ▶ TY to BY- Inflation
  - ▶ Man Year- % hours/year
  - ▶ OperSch- # Outfits per year

Outfits Personn...logy (BY2012\$M)						
	WBS/CES Description	Unique ID	Point Estimate	Phasing	Equation / Throughput	
99	MP DIRECT FUNDED ELEMENTS	MPS	\$ 521.600 *	F		
100	CREW- OUTFIT		\$ 476.331 *			
101	CREW- ACTIVE		\$ 382.026 *	F	$(\text{AVG}(\text{MATVAL}(\text{@MilPers\_31B}, 1, 1)), \text{MATVAL}(\text{@MilPers\_31D}, 1, 1)), \text{MATVAL}(\text{@MilPers\_311A}, 1, 1))) * \text{AMCOS\_}\$ \_ \text{Correction} * \text{TYTOBY}(\text{MPA}, 2012, \text{FYBY}) * \text{Outfit\_ManYear} * \text{OperSch\_Outfit\_Active}$	
102	CREW NATIONAL GUARD		\$ 69.868 *	F	$(\text{AVG}(\text{MATVAL}(\text{@MilPers\_31B}, 1, 2)), \text{MATVAL}(\text{@MilPers\_31D}, 1, 2)), \text{MATVAL}(\text{@MilPers\_311A}, 1, 2))) * \text{AMCOS\_}\$ \_ \text{Correction} * \text{TYTOBY}(\text{MPA}, 2012, \text{FYBY}) * \text{Outfit\_ManYear} * \text{OperSch\_Outfit\_NG}$	
103	CREW ARMY RESERVE		\$ 24.436 *	F	$(\text{AVG}(\text{MATVAL}(\text{@MilPers\_31B}, 1, 3)), \text{MATVAL}(\text{@MilPers\_31D}, 1, 3)), \text{MATVAL}(\text{@MilPers\_311A}, 1, 3))) * \text{AMCOS\_}\$ \_ \text{Correction} * \text{TYTOBY}(\text{MPA}, 2012, \text{FYBY}) * \text{Outfit\_ManYear} * \text{OperSch\_Outfit\_AR}$	

# Military Personnel Cost Example

## Improvements to Come

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- ▶ **AMCOS database for personnel costs**
  - ▶ Query by categories to narrow results
  - ▶ Multiple queries for one MOS
    - ▶ Tedious
    - ▶ Colors, formats, craziness
    - ▶ A lot of manipulation

## Improvement:

- ▶ **Joint Integrated Analysis Tools (JIAT) and AMCOS inputs**
  - ▶ JIAT new method – in beta form
  - ▶ Cuts query time- one query instead of three



# Military Personnel Cost Example

## Improvements to Come

Data Query Inputs

Inputs	
Name	Value
1 Pay Plan	Active Enlisted
2 Summary	Pay and Allowances, PCS, and Training
3 Group	88 : TRANSPORTATION
4 Sub Group	88M : MOTOR TRANSPORT OPERATOR
5 APPN	ALL
6 Category	SUM
7 Element	N/A
8 Locality	N/A
9 Area	N/A

Run Query Cancel

Outfits Personnel.aceit - Yearly Phasing (BY2012\$M)

	WBS/CES Description	Phasi nn	Unique ID	FY 2012	FY 2013	FY 2014	F
626	*MP Inputs						
627	*AMCOS MP Inputs (Avg)			Active	NG	AR	
628	31B		MilPers_31B				
629	Pay and Allowances	I		75000	10000	8000	
630	MPA Training	I		1500	1000	1200	
631	PCS	I		4000			
632	OMA & Other	I		5000	2000	1000	
633	31D		MilPers_31D				
634	Pay and Allowances	I		90000	12000	10000	
635	MPA Training	I		5000	100	100	
636	PCS	I		4000			
637	OMA & Other	I		16000	100	150	
638	311A		MilPers_311A				
639	Pay and Allowances	I		140000	15000	17000	
640	MPA Training	I		100	3000	4000	
641	PCS	I		4000			
642	OMA & Other	I		5000	2000	1100	

Methodology \ Yearly Phasing \ All Columns /

	A	C	D	E	F	G	H	I	J	K	L
1	Query Inputs			Query Results							
2	Name	Value	Summary	APPN	Category	Element	Year	E1	E2	E3	E4
3	Pay Plan	Active Enlisted	Pay and Allowances	MPA TOTAL	SUM	SUM	2012	30,000.00	45,000.00	50,000.00	55,000
4	Summary	Pay and Allowances, PCS, and Training	PCS	MPA TOTAL	SUM	SUM	2012	300	150	300	500
5	Group	88 : TRANSPORTATION	Training	MPA TOTAL	SUM	SUM	2012	4,000.00	2,000.00	2,200.00	2,600
6	Sub Group	88M : MOTOR TRANSPORT OPERATOR	Training	OMA TOTAL	SUM	SUM	2012	5,500.00	3,000.00	2,900.00	4,000
7	APPN	ALL	Training	Other TOTAL	SUM	SUM	2012	4,100.00	3,500.00	3,000.00	3,200
8	Category	SUM									

# Summary

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- ▶ Using matrices...
  - ▶ saves rows
  - ▶ decreases number of Unique IDs
  - ▶ saves time (Tecolote Research Jan 2009)
    - ▶ flexible, data is easily modified
    - ▶ scalable, easy to increase/decrease the size of matrix
    - ▶ repeatable, can use same equation on multiple rows
  - ▶ organizes data
- ▶ Site by Site Wizard
- ▶ Capabilities with JIAT and AMCOS

# Information Sources

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- ▶ Training Class/Materials
- ▶ ACE Help
- ▶ ACE Example Files
- ▶ ACE POC

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Thank you

Questions?