



Galaxy Charts

Depict and Color your WBS
in a Meaningful Way

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Patent Pending

2013 ICEAA Conference
June 18-21, 2013



Outline

- ▶ Example Data
- ▶ Problem Statement
- ▶ Galaxy Chart Overview
- ▶ Insights
- ▶ Colors
- ▶ Further Research and Enhancements
- ▶ Conclusions





Example Data

- ▶ Surface Combatant
 - Follow Ship
 - Derived from FY12 Budget

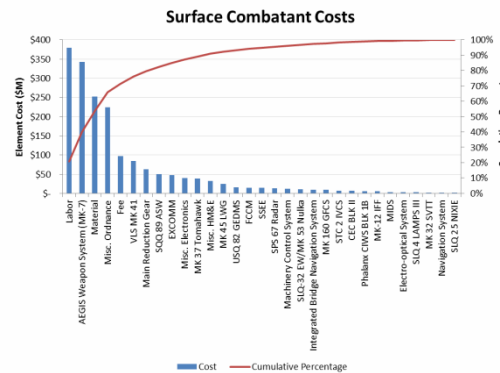
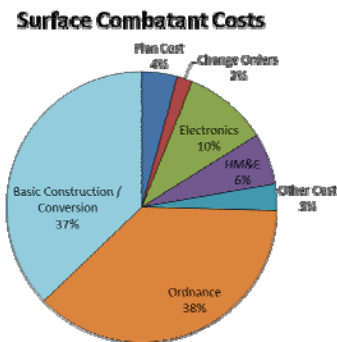


Element	Name	Cost FY13\$M
1.0	Surface Combatant	\$2,000
1.1	Plan Cost	\$85
1.2	Basic Construction/Conversion	\$743
1.2.1	Labor	\$379
1.2.2	Material	\$253
1.2.3	FCCM	\$15
1.2.4	Fee	\$97
1.3	Change Orders	\$37
1.4	Electronics	\$200
1.4.1	SQQ 89 ASW	\$50
1.4.2	SLQ-32 EW/MK 53 Nulka	\$10
1.4.3	USQ 82 GEDMS	\$16
1.4.4	EXCOMM	\$48
1.4.5	Navigation System	\$2
1.4.6	MK-12 IFF	\$5
1.4.7	SLQ 25 NIXIE	\$2
1.4.8	SLQ 4 LAMPS III	\$2
1.4.9	SSEE	\$15
1.4.10	MIDS	\$3
1.4.11	CEC BLK II	\$7
1.4.12	Misc. Electronics	\$40
1.5	HM&E	\$123
1.5.1	STC 2 IVCS	\$7
1.5.2	Main Reduction Gear	\$63
1.5.3	Machinery Control System	\$12
1.5.4	Integrated Bridge Navigation System	\$9
1.5.5	Misc. HM&E	\$32
1.6	Other Cost	\$63
1.7	Ordnance	\$748
1.7.1	AEGIS Weapon System (MK-7)	\$343
1.7.2	VLS MK 41	\$85
1.7.3	MK 45 LWG	\$24
1.7.4	MK 37 Tomahawk	\$39
1.7.5	Phalanx CIWS BLK 1B	\$6
1.7.6	MK 32 SVTT	\$2
1.7.7	Electro-optical System	\$3
1.7.8	MK 160 GFCS	\$9
1.7.9	SPS 67 Radar	\$13
1.7.10	Misc. Ordnance	\$224



Problem Statement

- ▶ **Challenge:** Why do insignificant cost elements often receive inappropriate attention?
 - Movement towards micro-level models
 - Misunderstood cost element relationships
 - Predetermined beliefs of the most important cost elements
 - Thoroughness
 - Inadequate, holistic, graphical presentation tools



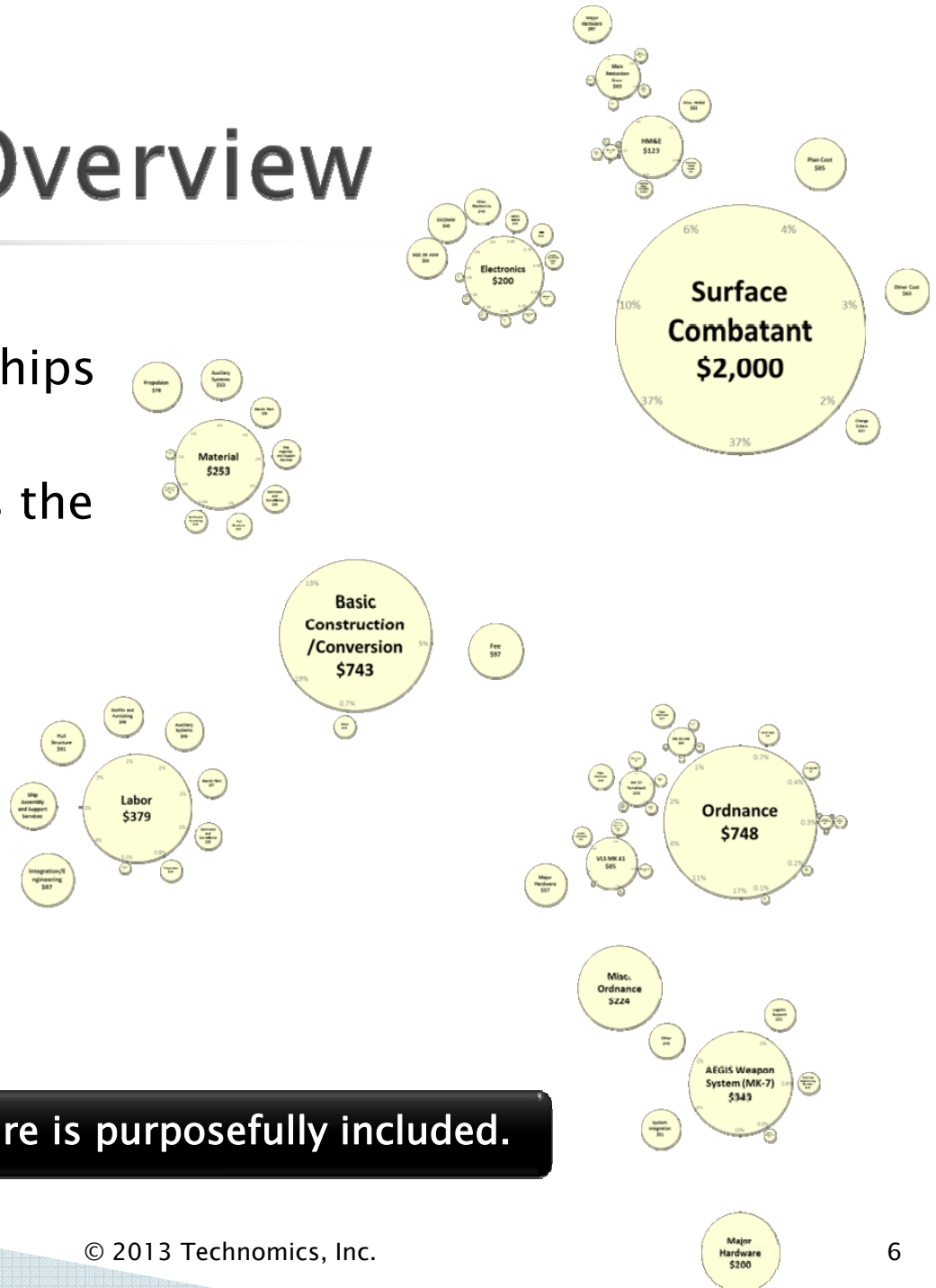
	FY13SM	FY13SM % of Total	FY13SM	% of Category
Surface Combatant	\$2,000			
Plan Cost	\$85	4.3%		
Basic Construction/Conversion	\$743	37.2%		
Change Orders	\$37	1.9%		
Electronics	\$200	10.0%		
HM&E	\$123	6.1%		
Other Cost	\$63	3.2%		
Ordnance	\$746	37.4%		
Labor	\$ 379.16	51.0%		
Material	\$ 252.77	34.0%		
FCCM	\$ 14.87	2.0%		
Fee	\$ 96.65	13.0%		
SOQ 89 ASW	\$ 50.34	25.2%		
SLQ 32 EW/MK 53 Nulka	\$ 10.16	5.1%		
USQ 89 GEDMS	\$ 15.62	7.8%		
EXCONIM	\$ 47.58	23.8%		
Navigation System	\$ 2.17	1.1%		
MK-12 JFF	\$ 4.96	2.5%		
SLQ 25 NIXIE	\$ 2.16	1.1%		
SLQ 4 LAMPS III	\$ 2.45	1.2%		
SSEE	\$ 14.67	7.3%		
MIDS	\$ 3.40	1.7%		
CEC BLK II	\$ 6.77	3.4%		
Misc. Electronics	\$ 39.64	19.8%		
STC 2 IVCS	\$ 7.03	5.7%		
Main Reduction Gear	\$ 63.05	51.3%		
Machinery Control System	\$ 11.66	9.5%		
Integrated Bridge Navigation System	\$ 9.35	7.6%		
Misc. HM&E	\$ 31.79	25.9%		
AEGIS Weapon System (MK-7)	\$ 342.62	45.8%		
VLS MK 41	\$ 84.70	11.3%		
MK 45 LWG	\$ 24.47	3.3%		
MK 37 Tomahawk	\$ 38.85	5.2%		
Phalanx CIWS BLK 1B	\$ 6.05	0.8%		
MK 32 SVTT	\$ 2.35	0.3%		
Electro-optical System	\$ 3.07	0.4%		
MK 160 GFCS	\$ 8.89	1.2%		
SPS 67 Radar	\$ 13.36	1.8%		
Misc. Ordnance	\$ 223.71	29.9%		

- ▶ **Constraint:** Most cost data housed in a WBS



Galaxy Chart Overview

- ▶ Shows all WBS elements, magnitudes, and relationships
- ▶ Total Cost, i.e., the Sun, is the focal point
- ▶ Children, i.e., the Planets “orbit” the Sun; relative magnitudes are easily discernible
- ▶ Lines between elements illustrate relationships

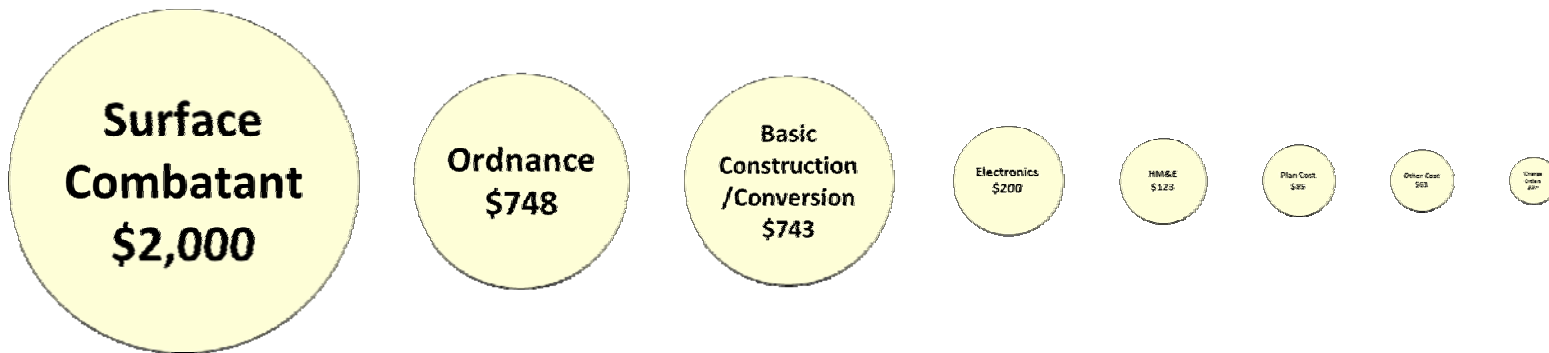


Every design feature is purposefully included.



Circle Sizing

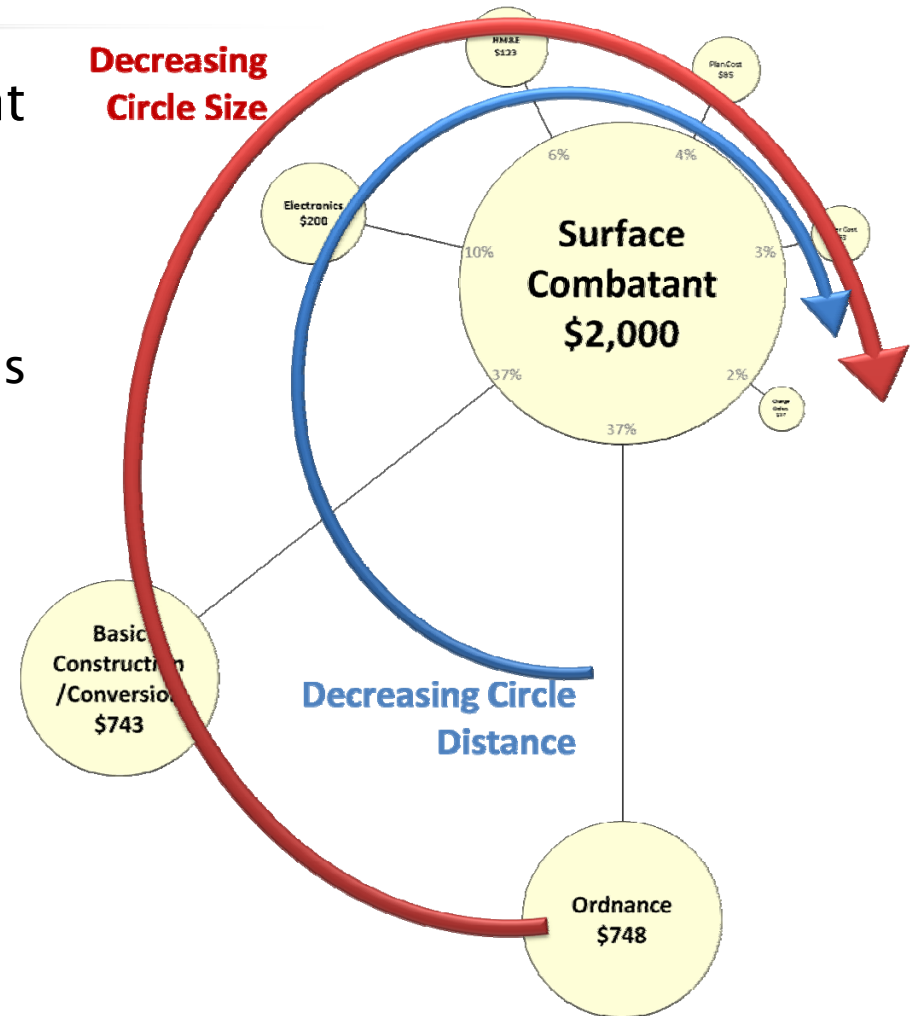
- ▶ All circles are sized by area relative to the Sun
 - Parent-level area = $\sum(\text{Child-level areas})$
 - Large cost elements are large circles
 - Small cost elements are small circles
- ▶ Large, emphasized circles are by design
- ▶ Small, unreadable circles are also by design





Circle Location

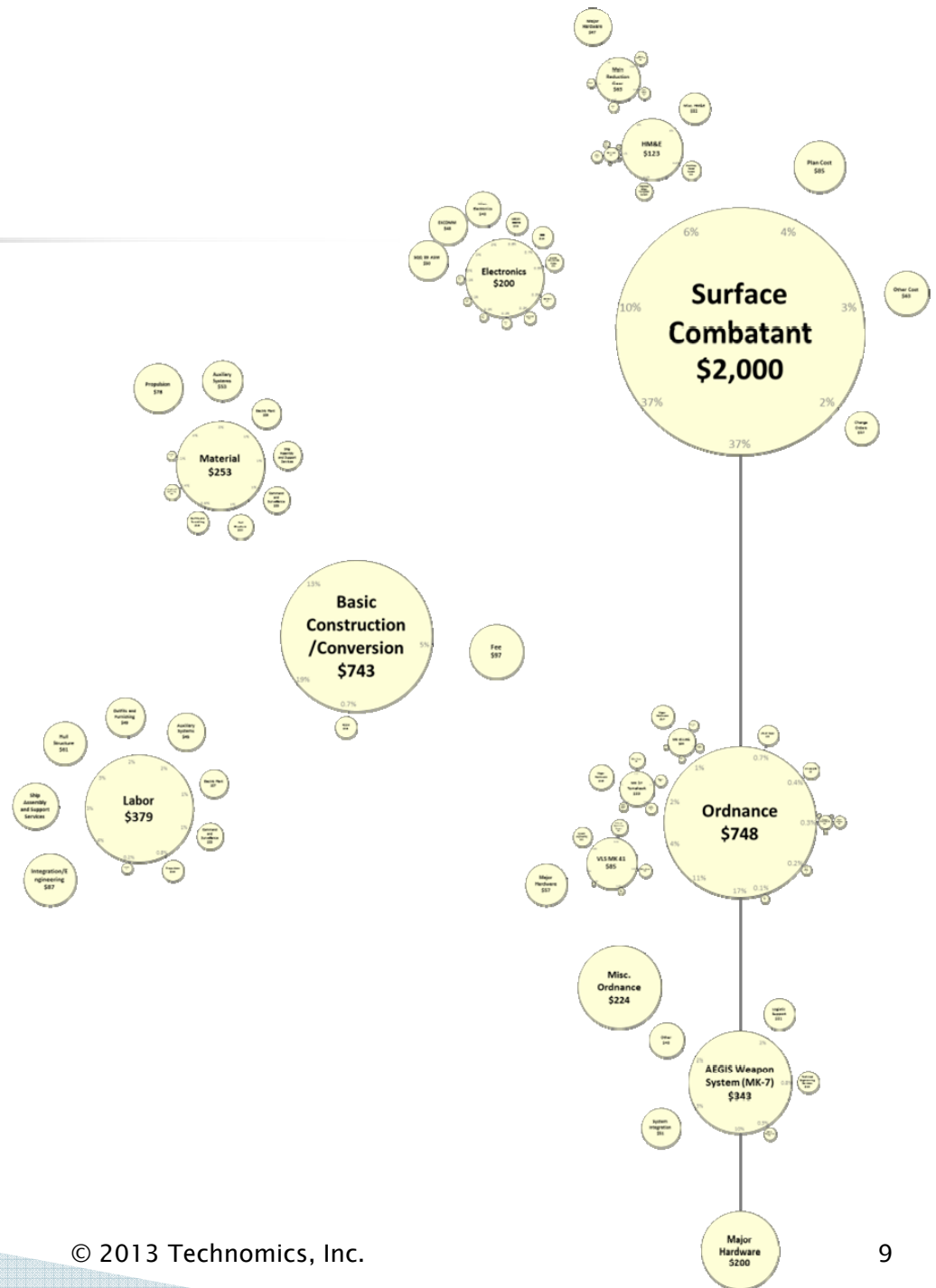
- ▶ Children–circles orbit the parent in a clockwise manner, at an ever–decreasing distance
 - Largest child of Total Cost begins below Total Cost at 180°
 - Remaining children are ordered largest to smallest and evenly spaced around the parent
 - Distance between parent and children decreases relative to child’s cost





Other Features

- ▶ **Circle**
 - Colors: light yellow to emphasize labels; black circumference line
- ▶ **Labels**
 - Scaled for size
 - Contain element name and dollar amount
 - Color: black to contrast with light yellow background
- ▶ **Percentages**
 - Relative contribution to the total cost
 - Color: gray so this information does not distract from the labels
- ▶ **Lines**
 - Color: black, same as for the circle circumference

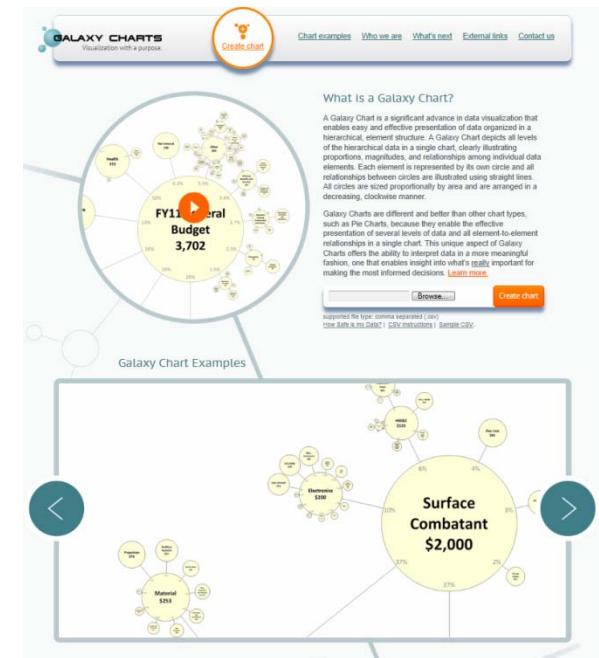




Automated Construction

- ▶ Technomics developed a website that will automatically draw galaxy charts
 - Upload your data → download the Galaxy Chart
- ▶ Web-based tool
 - No installation necessary
 - Works on any computer
- ▶ Data Security
 - Utilizes 128/256 bit SSL security
 - Data not stored beyond user session
- ▶ Price: *Free*

www.galaxycharts.com





Galaxy Chart Insights

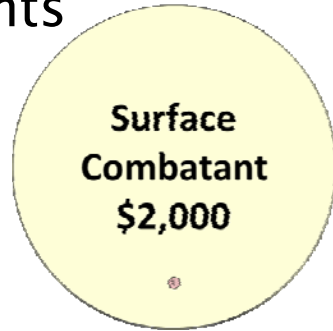
- ▶ Initial Estimate
- ▶ Analysis of Alternatives (AoA)
- ▶ Independent Cost Estimate (ICE) vs. Initial Estimate reconciliation
- ▶ Earned Value Management (EVM)



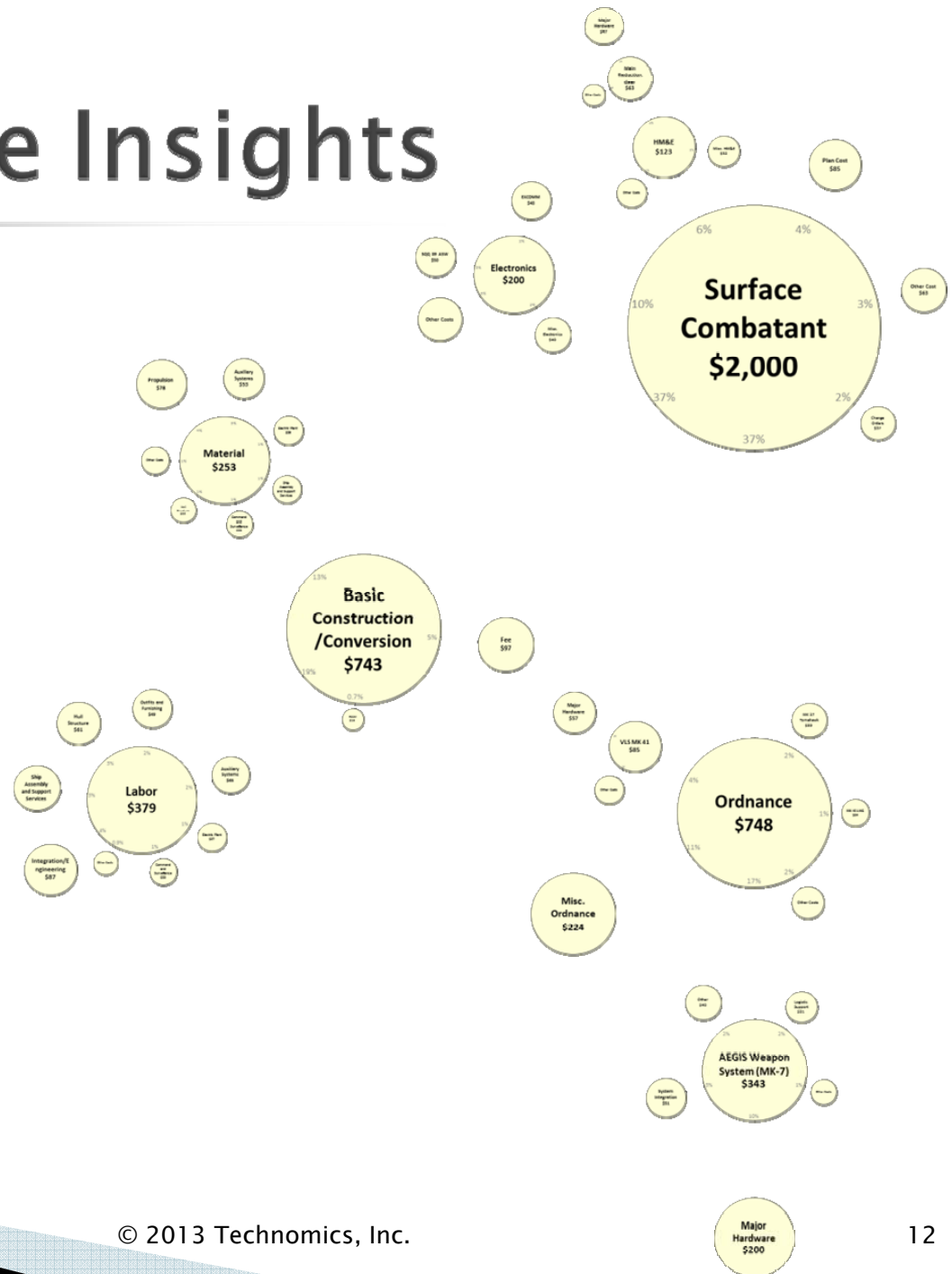


Initial Estimate Insights

- ▶ Identification of large cost elements



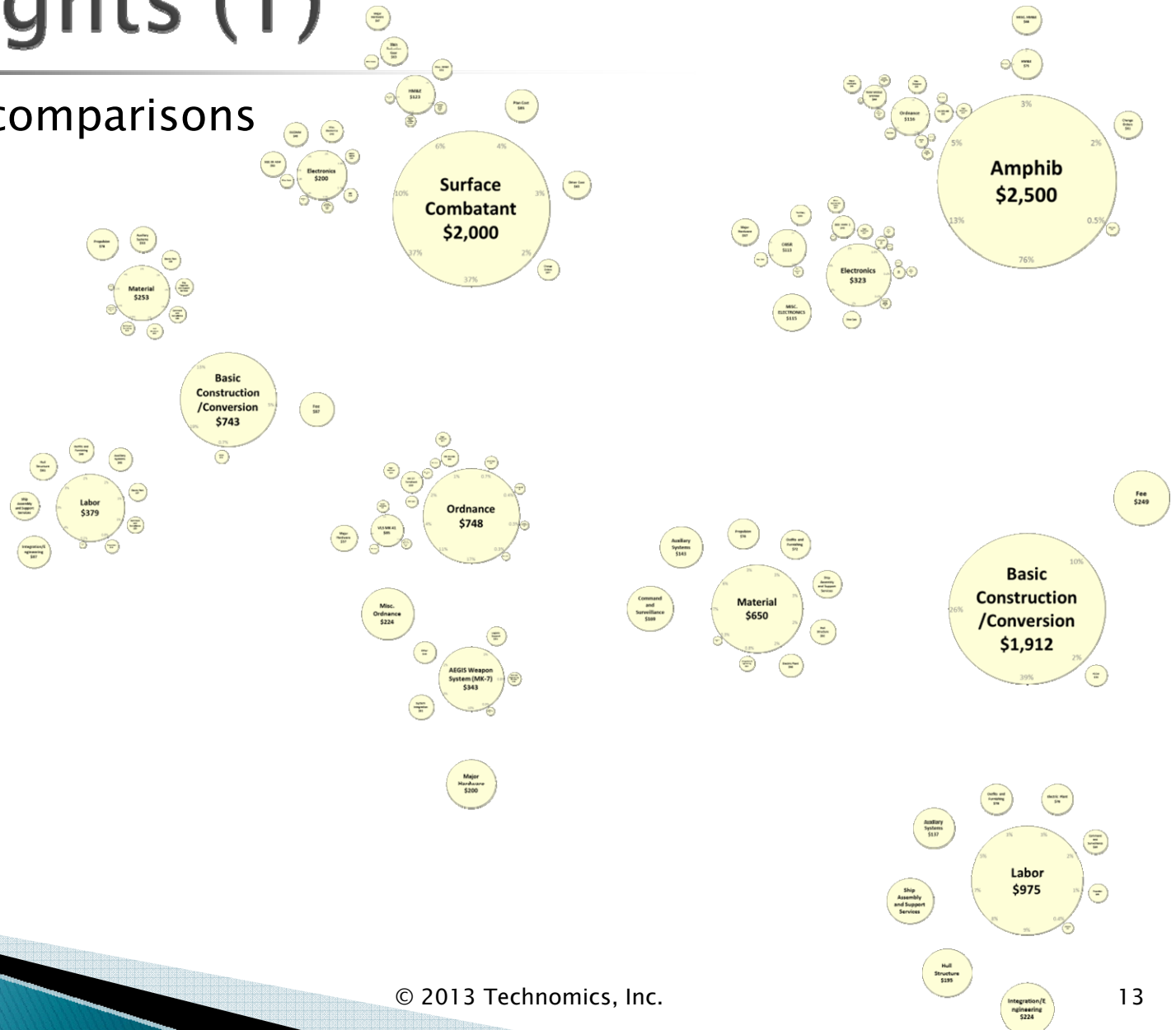
- ▶ Removal of small circles
- ▶ Comparisons between dis-similar elements





AoA Insights (1)

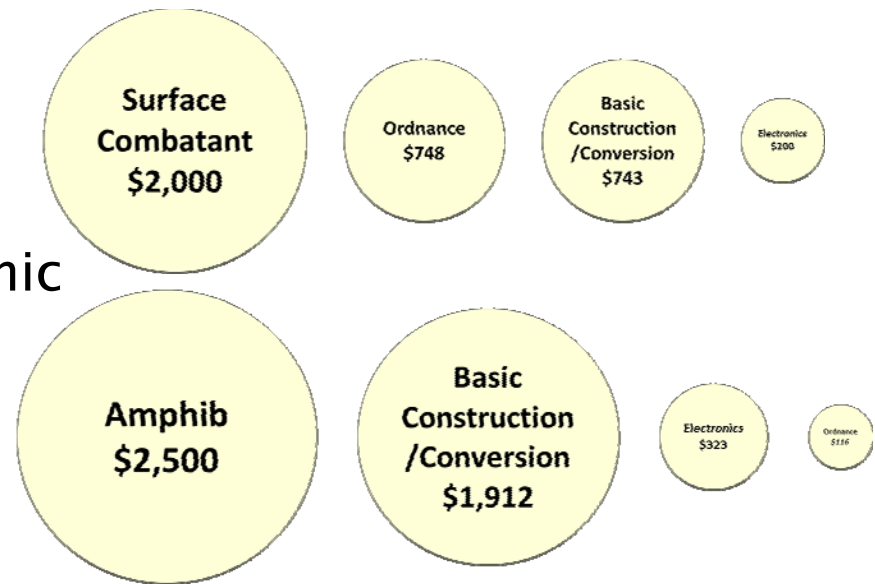
- ▶ Side-by-side comparisons of ship types





AoA Insights (2)

- ▶ Circle Order
 - Largest to smallest
- ▶ Circle Sizing
 - Amphib BCC > Combatant BCC
 - Amphib BCC \cong Total Surface Combatant
- ▶ Linkage to a cost model...dynamic Galaxy charts
 - Changing line segments
 - Changing circle sizes
 - Changing numeric text



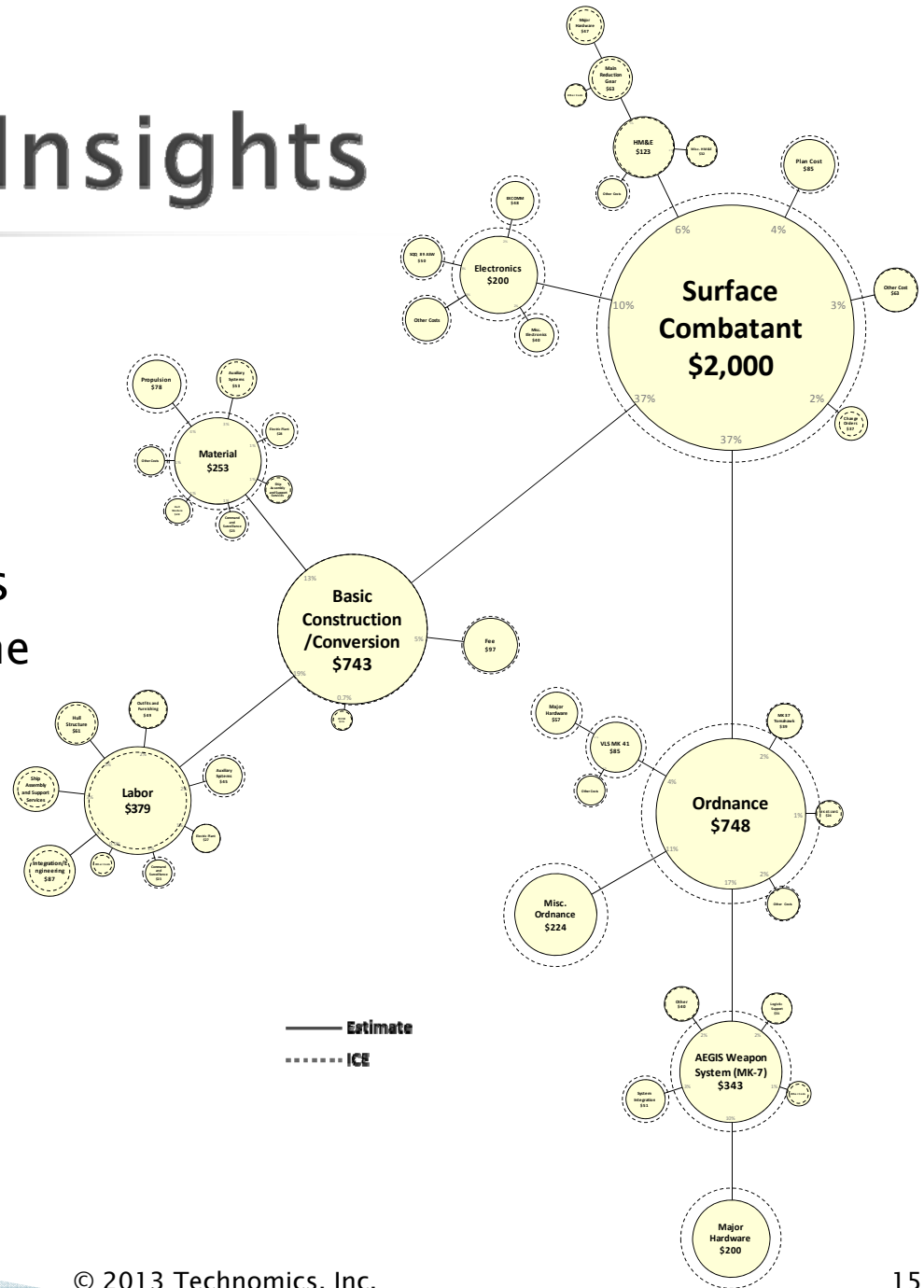
BCC: Basic Construction/Conversion



Reconciliation Insights

- ▶ Superimpose the ICE on the Initial Estimate
 - Dashed line is the ICE

- ▶ Identify *significant* differences
 - The AEGIS weapon system is the most significant contributor to Ordnance cost divergence
 - The two estimates for Basic Construction are virtually identical, but components are not

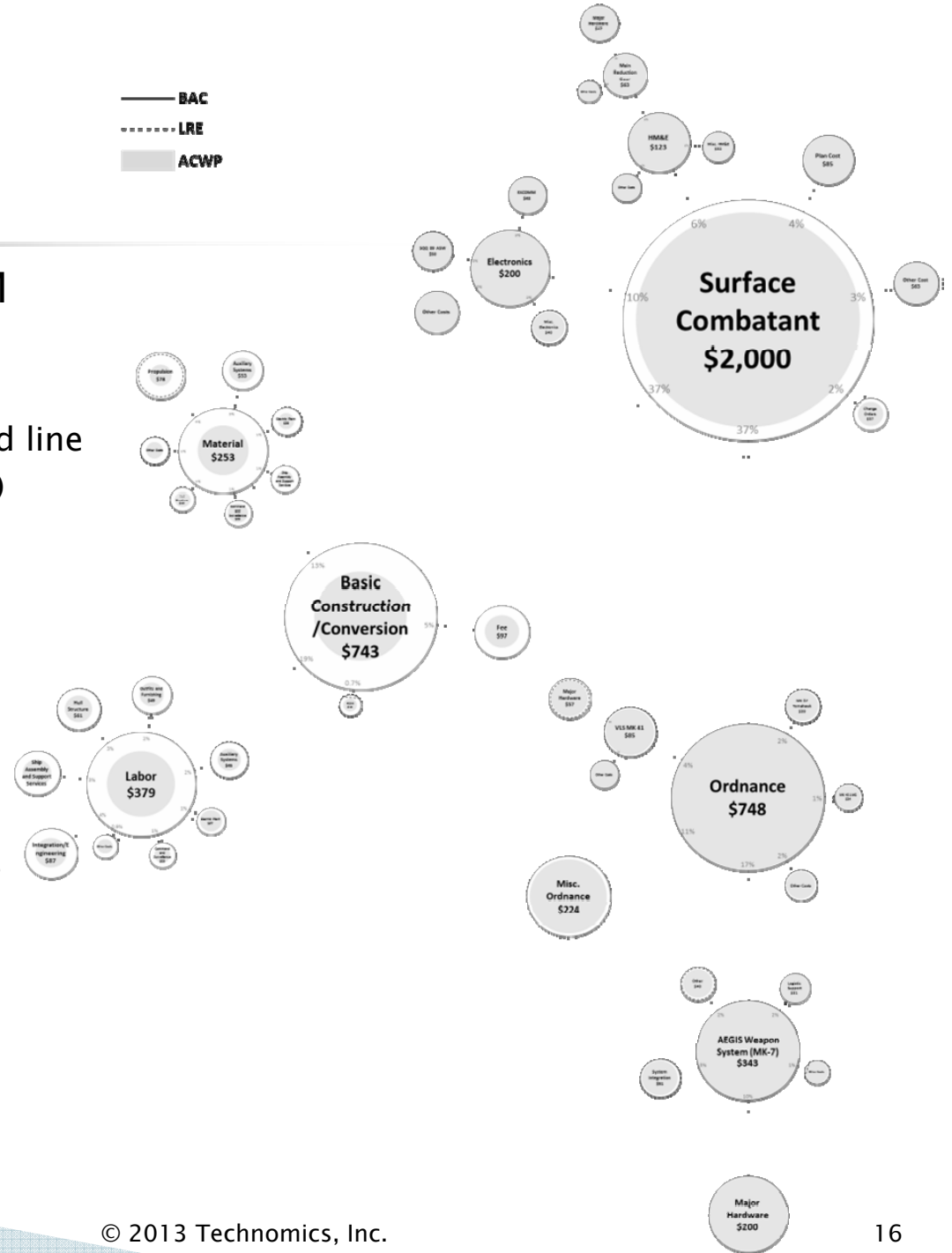




EVM Insights

- ▶ Summarize three important EVM metrics on the same chart:
 - Budget at Complete (BAC) – solid line
 - Latest Revised Estimate (LRE) – dashed line
 - Actual Cost of Work Performed (ACWP) – shaded line
- ▶ Visualize WBS element effort–sequencing
 - Basic Construction is “last”
- ▶ Indicate actual and potential overruns, i.e., $LRE > BAC$
- ▶ Show WBS element relationships
- ▶ Add time–dimension with “flipbook” of multiple charts

— BAC
 - - - LRE
 ■ ACWP





Limitations of Galaxy Charts

- ▶ “Real relationships” are not shown
 - Subject to structure of WBS
- ▶ Qualitative metrics cannot be shown
- ▶ Averages / indices do not roll-up and therefore cannot be shown
- ▶ Negative values cannot be shown

Carefully
Use
Color to
show



“...the fundamental uses of color in informational design: *to label, to measure, to represent or imitate reality, and to enliven or decorate.*”
~ Edward Tufte

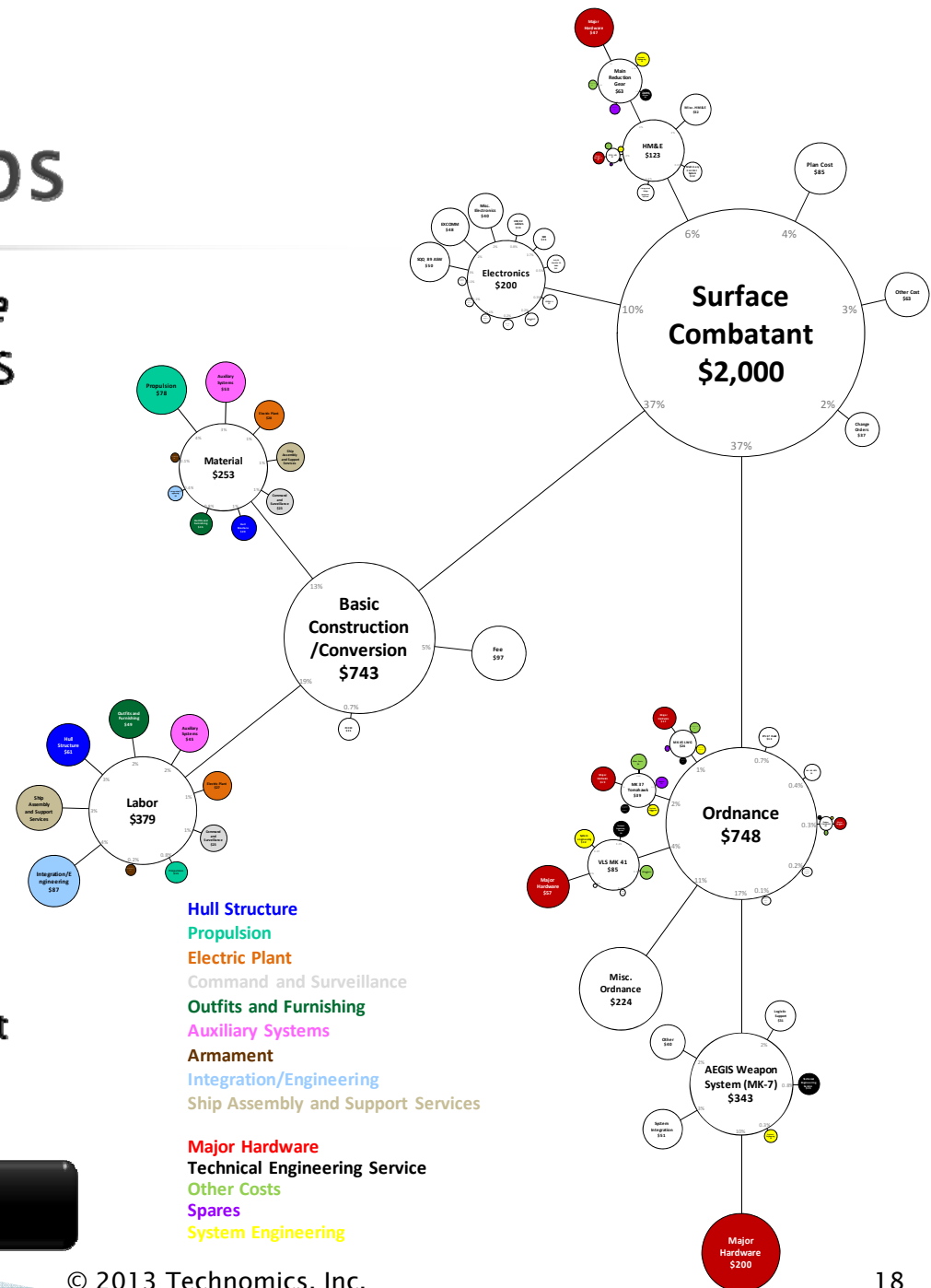
Envisioning Information, Graphics Press,
1990, p 81.



Real Relationships

“Represent or imitate reality” – Tufte

- ▶ Show Relationships hidden by WBS
 - ❖ WBS is often a structure that is well organized, but may not represent reality
- ▶ Color related elements with the same color
 - ❖ Major Hardware, Systems Engineering, Spares, Technical Engineering, Other Costs, SWBS Groups
- ▶ Use pattern recognition to gain additional insights
 - ❖ Elements repeat – other relationships may exist
 - ❖ Major hardware is always most important
 - ❖ Labor & Material relative sizes are unrelated



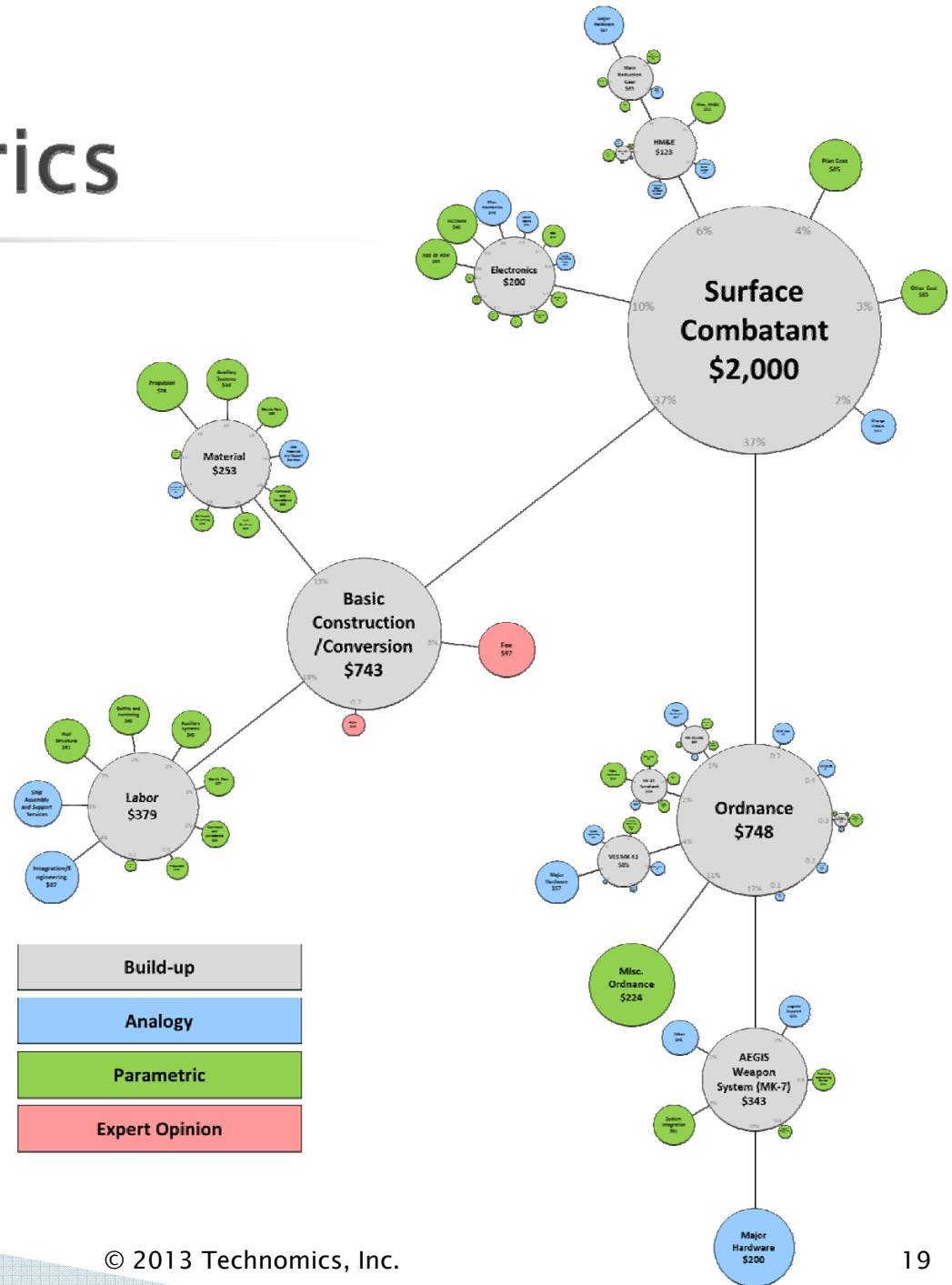
Overcomes a shortcoming of the WBS



Qualitative Metrics

“Label” – Tufte

- ▶ Brings visibility into the holistic view of your estimate
 - Continue to see your entire estimate
 - See the relative percentages of the metric
- ▶ Show any qualitative metric
 - Methodologies
 - Risk
 - Data Sources
 - Etc.





Ordinal Metrics

High Risk

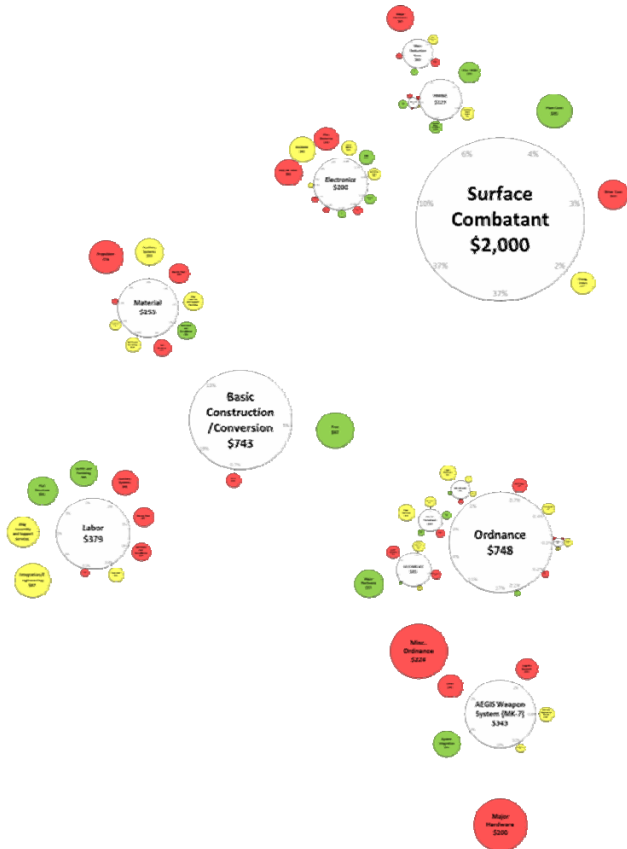
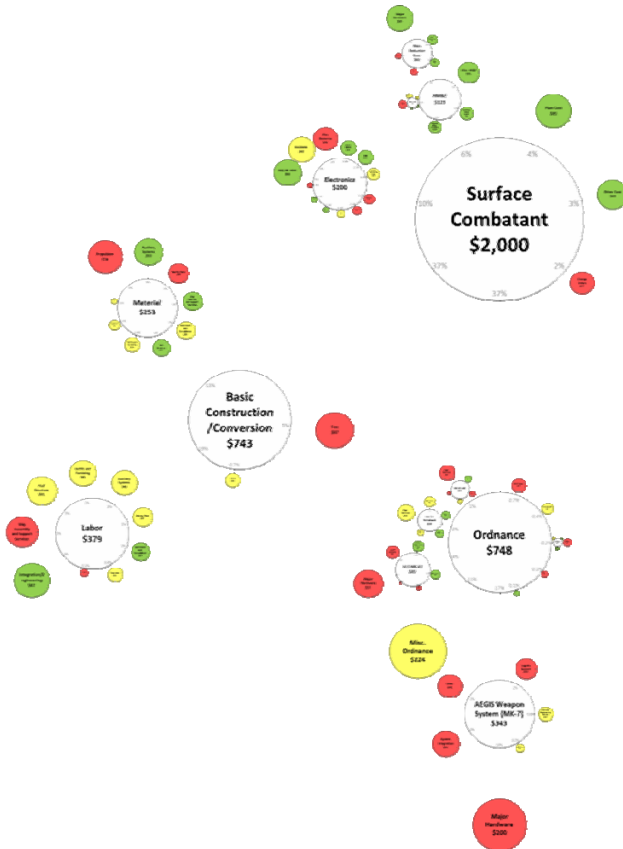
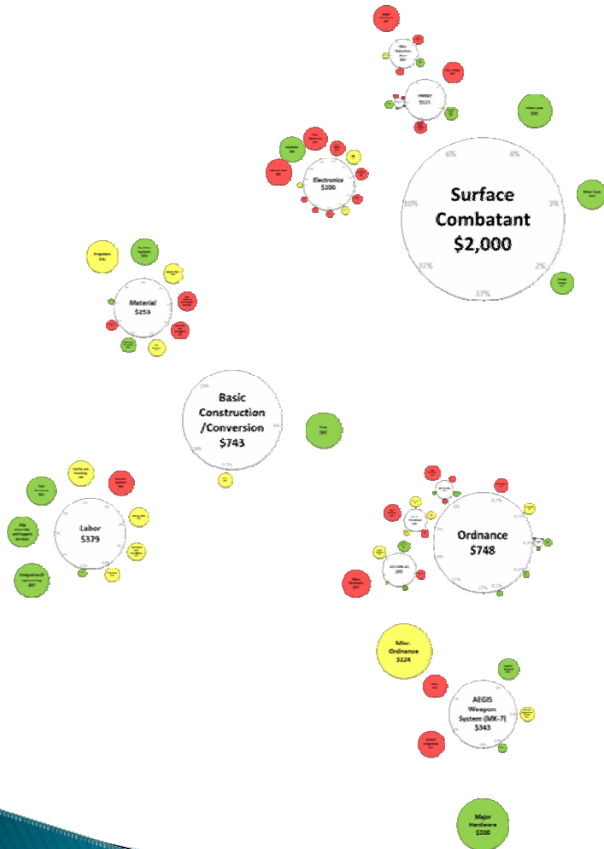
Medium Risk

Low Risk

Cost Risk

Technical Risk

Schedule Risk

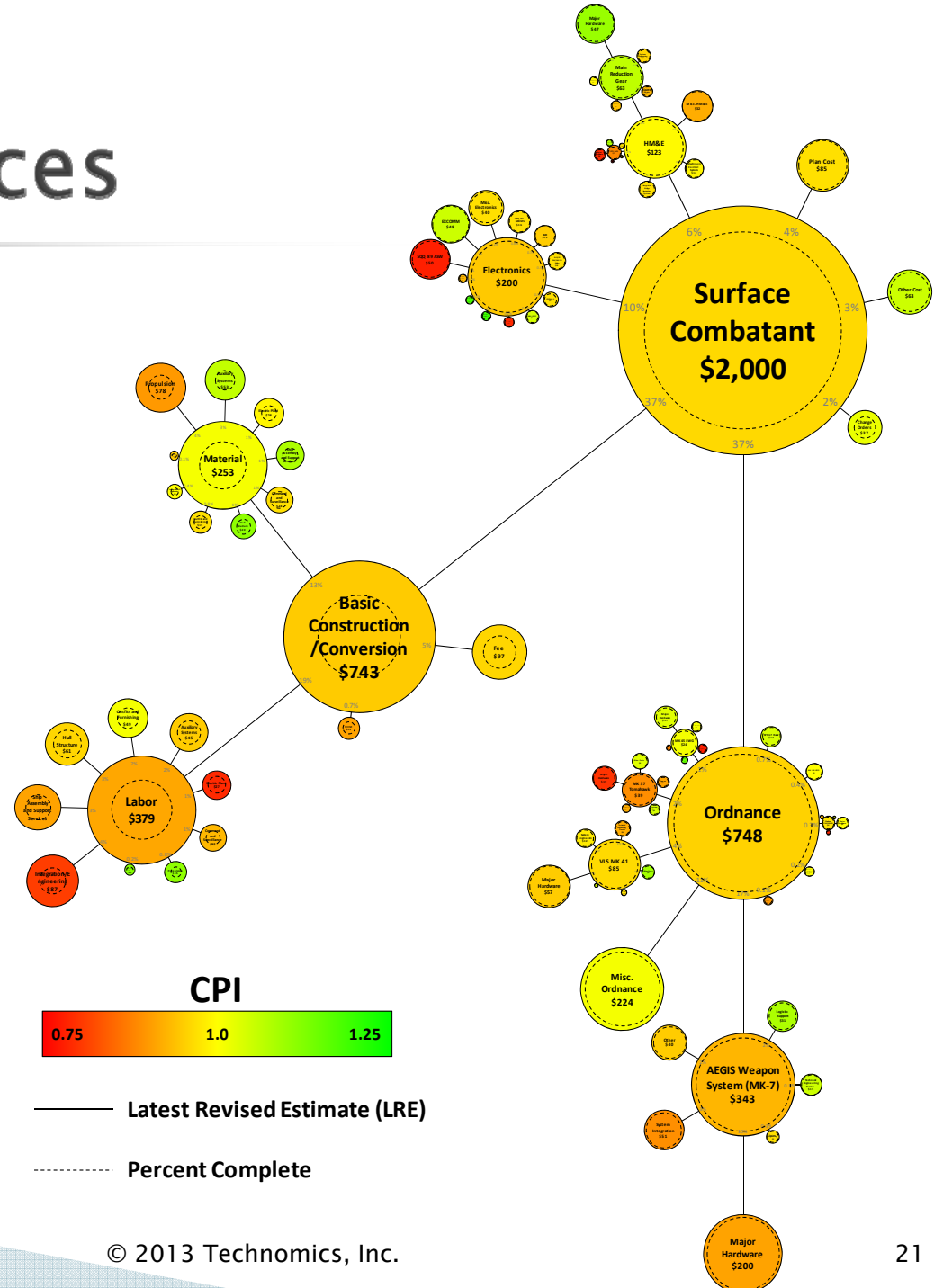




Averages / Indices

“Measure” – Tufte

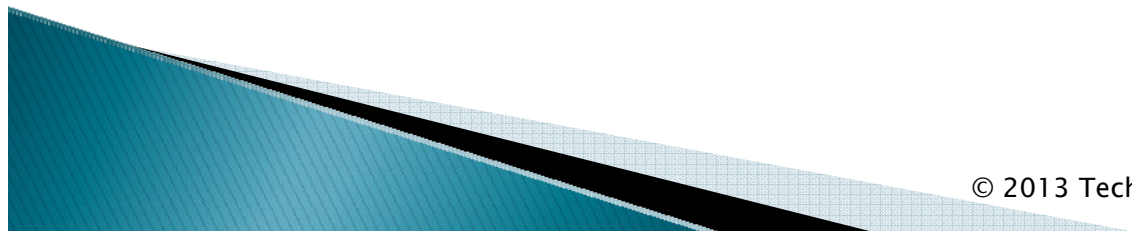
- ▶ Show a separate quantitative metric using colors
 - Create a heat map
- ▶ Allows for the usage of averages or indices
 - Cost Performance Index (CPI)
 - Schedule Performance Index (SPI)
 - To-complete Cost Performance Index (TCPI)
 - Etc.
- ▶ Clearly shows outliers
- ▶ Continues to show the index within the WBS
 - Shows how outliers affect parent elements





Galaxy Charts Summary

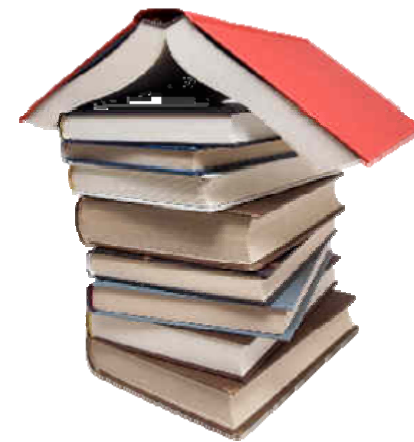
- ▶ We originally created Galaxy Charts to visually
 - Identify significant and less significant cost elements
 - Characterize relationships among cost elements
 - Enable comparisons between dis-similar cost elements
- ▶ With the addition of color we added new visual capabilities
 - Real relationships
 - Qualitative metrics
 - Averages and indices





Further Research and Enhancements

- ▶ Use the circle-to-circle line segments to add another dimension
- ▶ Determine how to appropriately display negative values on a Galaxy Chart
- ▶ 3-Dimensional model of the Galaxy Chart
- ▶ Software Enhancements





References

- ▶ *Department of the Navy Fiscal Year (FY) 2012 Budget Estimates, Shipbuilding and Conversion, Navy.* (2011, February). Retrieved March 1, 2012, from Office of the Assistant Secretary of the Navy, Financial Management and Comptroller: http://www.finance.hq.navy.mil/FMB/12pres/SCN_BOOK.pdf
- ▶ Cooper, L., & Plowden, L. (2010, April 30). *Business Case Analysis.* Retrieved March 1, 2012, from Slideshare: <http://www.slideshare.net/Timothy212/powerpoint-document-business-case-analysis>
- ▶ NAVSEA. (2005). *Cost Estimating Handbook.* Washington, DC: SEA 017.
- ▶ Society of Cost Estimating and Analysis. (2010). *Cost Estimating Body of Knowledge.*
- ▶ Tufte, E. R. (1990). *Envisioning Information.* Cheshire, Connecticut: Graphics Press LLC.
- ▶ Tufte, E. R. (1997). *Visual Explanations.* Cheshire, Connecticut: Graphics Press LLC.
- ▶ Tufte, E. R. (2001). *The Visual Display of Quantitative information* (2 ed.). Cheshire, Connecticut: Graphics Press LLC.
- ▶ Tufte, E. R. (2006). *Beautiful Evidence.* Cheshire, Connecticut: Graphics Press LLC.





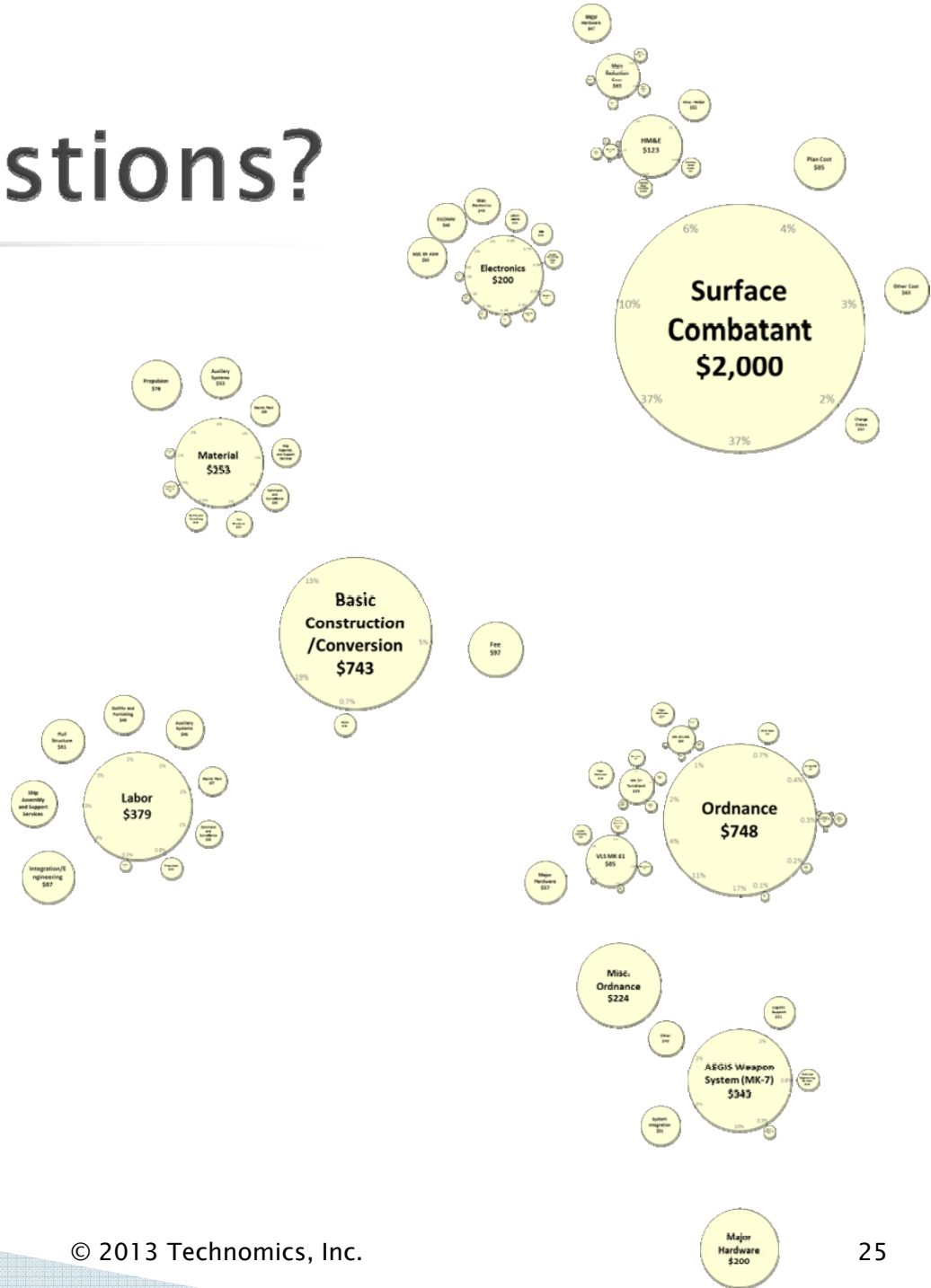
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Generate your own for free at www.galaxycharts.com



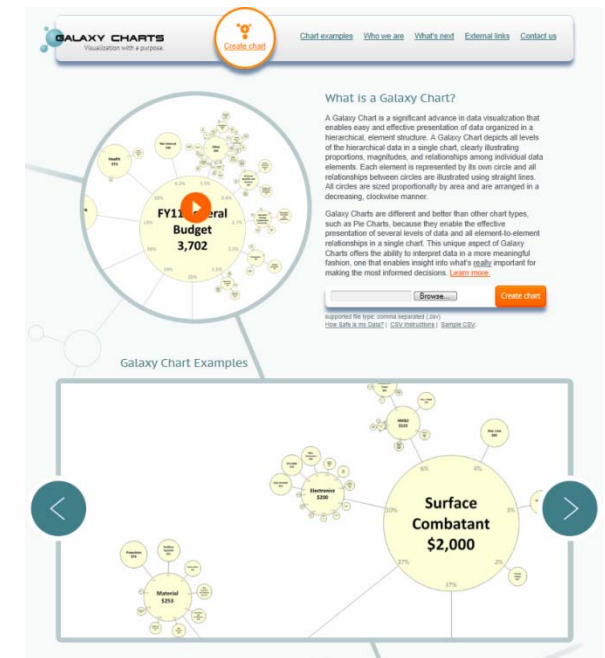


Backup



Website Overview

- ▶ Technomics has developed a website that will automatically draw galaxy charts
 - Upload your data → download the Galaxy Chart
- ▶ Web-based tool
 - No installation necessary
 - Works on any computer
- ▶ Data Security
 - Utilizes 128/256 bit SSL security
 - Data not stored beyond user session
- ▶ Price: Free



www.galaxycharts.com



Example Data

WBS Element	FY12 Dollars
Total Budget	\$690.50
Air Force	\$166.20
Aircraft	\$45.90
Construction	\$2.60
Maintenance	\$54.60
Personnel	\$36.60
Research	\$26.50
Army	\$211.90
Construction	\$7.10
Maintenance	\$92.20
Personnel	\$66.40
Research	\$10.70
Tanks	\$35.50
Defense-Wide	\$132.90
Navy	\$148.90
Construction	\$4.00
Maintenance	\$50.60
Personnel	\$31.60
Research	\$19.10
Ships	\$43.60
USMC	\$30.60
Maintenance	\$9.60
Personnel	\$16.10
Tanks	\$4.90



- Remove Totals
- Re-format WBS Columns

Service	Activity	FY12Dollars
Air Force	Aircraft	45.9
Air Force	Construction	2.6
Air Force	Maintenance	54.6
Air Force	Personnel	36.6
Air Force	Research	26.5
Army	Construction	7.1
Army	Maintenance	92.2
Army	Personnel	66.4
Army	Research	10.7
Army	Tanks	35.5
Defense-Wide		132.9
Navy	Construction	4.0
Navy	Maintenance	50.6
Navy	Personnel	31.6
Navy	Research	19.1
Navy	Ships	43.6
USMC	Maintenance	9.6
USMC	Personnel	16.1
USMC	Tanks	4.9

Data Source: www.usfederalbudget.us



Data Formatting



Row 1:
Column
Headings

Column 1:
Level 1
Categories

Column 2:
Level 2
Categories

Last Column:
Circle
Values

	A	B	C
1	Service	Activity	FY12Dollars
2	Air Force	Construction	2.6
3	Air Force	Personnel	36.6
4	Air Force	Maintenance	54.6
5	Air Force	Aircraft	45.9
6	Air Force	Research	26.5
7	Army	Construction	7.1
8	Army	Personnel	66.4
9	Army	Maintenance	92.2
10	Army	Tanks	35.5
11	Army	Research	10.7
12	Defense-Wide		132.9
13	Navy	Personnel	31.6
14	Navy	Maintenance	50.6
15	Navy	Procurement	43.6
16	Navy	Research	19.1
17	Navy	Construction	4
18	USMC	Personnel	16.1
19	USMC	Maintenance	9.6
20	USMC	Tanks	4.9
21			

Note: Colors added for display purposes only



Data Formatting Notes

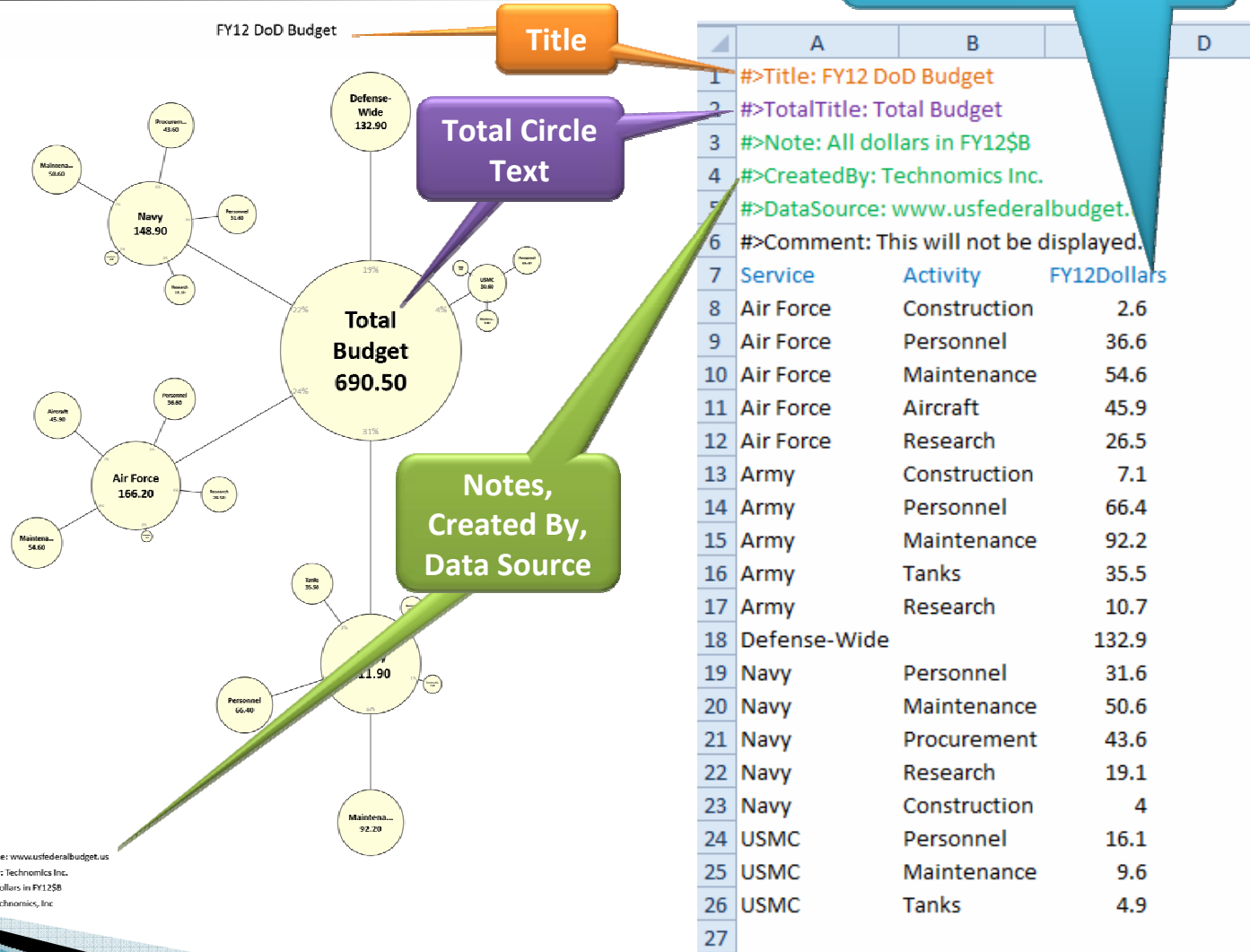
- Do not include totals – input only lowest level data
- More than 2 columns of categories are possible
- Categories can be blank (see Defense–Wide)
- Only include positive numbers
- Parent circles must have more than one child circle.

	A	B	C
1	Service	Activity	FY12Dollars
2	Air Force	Construction	2.6
3	Air Force	Personnel	36.6
4	Air Force	Maintenance	54.6
5	Air Force	Aircraft	45.9
6	Air Force	Research	26.5
7	Army	Construction	7.1
8	Army	Personnel	66.4
9	Army	Maintenance	92.2
10	Army	Tanks	35.5
11	Army	Research	10.7
12	Defense-Wide		132.9
13	Navy	Personnel	31.6
14	Navy	Maintenance	50.6
15	Navy	Procurement	43.6
16	Navy	Research	19.1
17	Navy	Construction	4
18	USMC	Personnel	16.1
19	USMC	Maintenance	9.6
20	USMC	Tanks	4.9
21			

Format your data in Microsoft Excel



Metadata (optional)



Note: Colors added for display purposes only



Metadata Notes

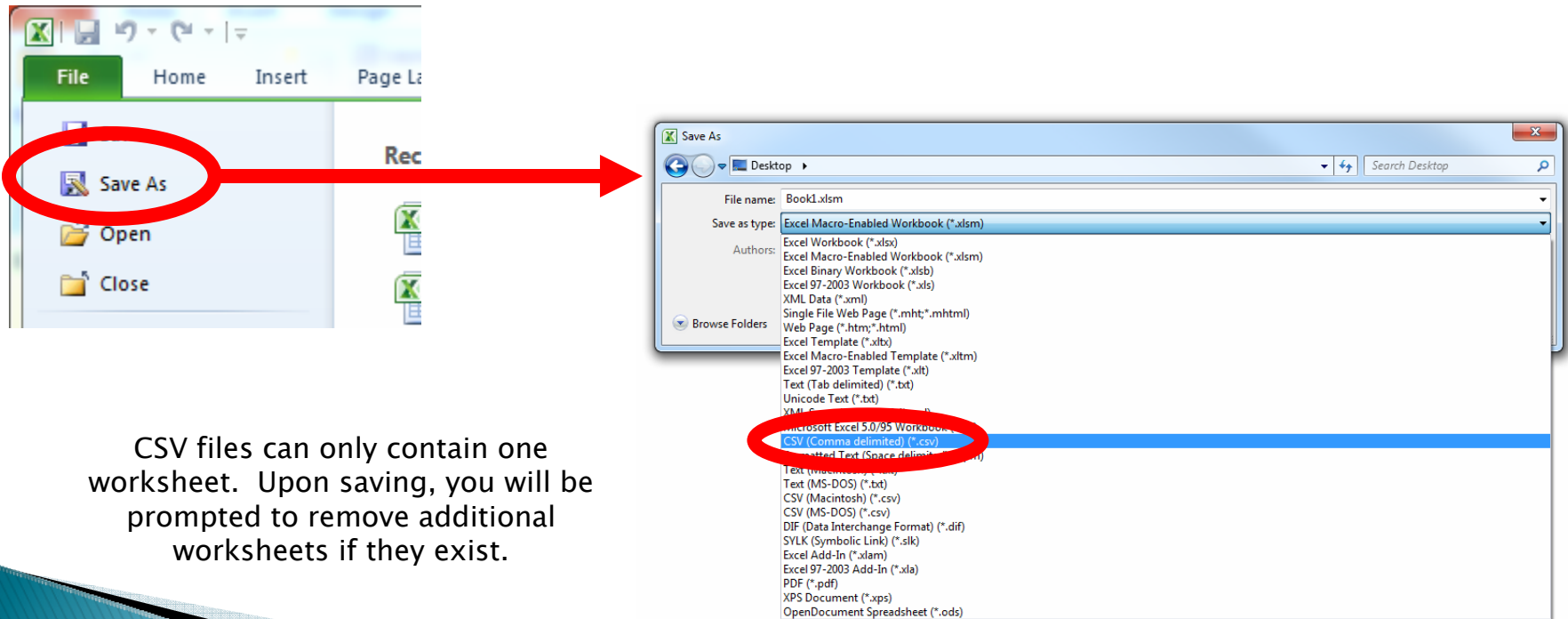
- All metadata is optional
- All metadata is preceded by #>
- There can be no spaces prior to colon
- Column Headings are required
- Commas are not permitted in metadata
- A 2nd column of related values will produce a 2nd circle (dashed).

	A	B	C	D
1	#>Title: FY12 DoD Budget			
2	#>TotalTitle: Total Budget			
3	#>Note: All dollars in FY12\$B			
4	#>CreatedBy: Technomics Inc.			
5	#>DataSource: www.usfederalbudget.us			
6	#>Comment: This will not be displayed.			
7	Service	Activity	FY12Dollars	
8	Air Force	Construction	2.6	
9	Air Force	Personnel	36.6	
10	Air Force	Maintenance	54.6	
11	Air Force	Aircraft	45.9	
12	Air Force	Research	26.5	
13	Army	Construction	7.1	
14	Army	Personnel	66.4	
15	Army	Maintenance	92.2	
16	Army	Tanks	35.5	
17	Army	Research	10.7	
18	Defense-Wide		132.9	
19	Navy	Personnel	31.6	
20	Navy	Maintenance	50.6	
21	Navy	Procurement	43.6	
22	Navy	Research	19.1	
23	Navy	Construction	4	
24	USMC	Personnel	16.1	
25	USMC	Maintenance	9.6	
26	USMC	Tanks	4.9	
27				



CSV's

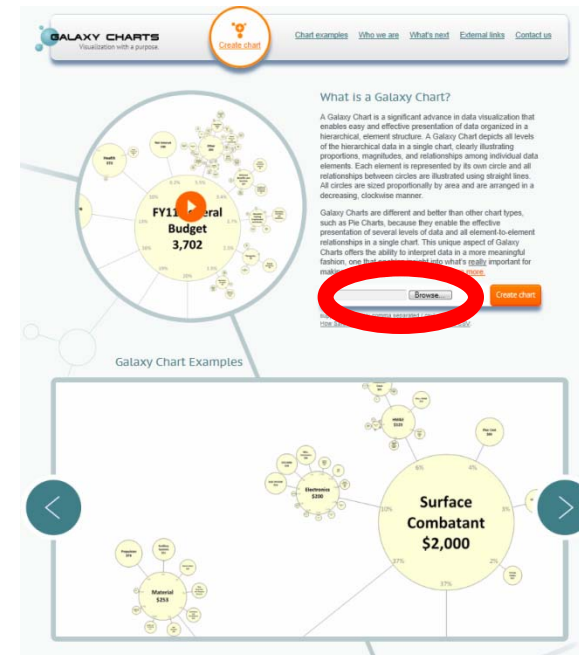
- ▶ In Excel:
 - Select Save As
 - Under Save as type, choose CSV (Comma delimited)





Uploading your CSV

- ▶ Go to www.galaxycharts.com
- ▶ Click Browse
- ▶ Select your CSV file
- ▶ Click Create Chart





Downloading your Galaxy Chart

The screenshot shows a web interface for downloading a Galaxy Chart. The main window is titled "Your Galaxy Chart is almost done!". On the left, a preview of a hierarchical chart is shown with a central node labeled "Total Budget 491". On the right, the "Terms of Service" are displayed, including the text: "This is an important legally binding agreement (this Agreement). It applies to your use of the Galaxy Charts™ Online Service, any software or related documentation, and any materials accessible or available at the web site located at www.galaxycharts.com (the Service). The owner of the Service is Technomics, Inc. (Technomics). This Agreement will refer to the user of the Service as you, whether the user is an individual or a legal entity. By clicking 'Accept' or by accessing or using the Service, you acknowledge that you have read, understood and agree to be bound by this Agreement. If you are a legal entity, the person who clicks 'Accept' or who accesses or uses the Services on behalf of that legal entity..."

At the bottom of the interface, there are several controls:

- 3 Choose Your Theme:** A row of six color swatches (yellow, blue, green, orange, grey, red).
- 4 Choose Your Resolution (Medium Recommended):** Two radio buttons for "Medium PNG, ~200Kb" and "High PNG, ~2Mb".
- 5 Download Your Galaxy Chart:** Two buttons: "Accept and Download" (highlighted in orange) and "Cancel".



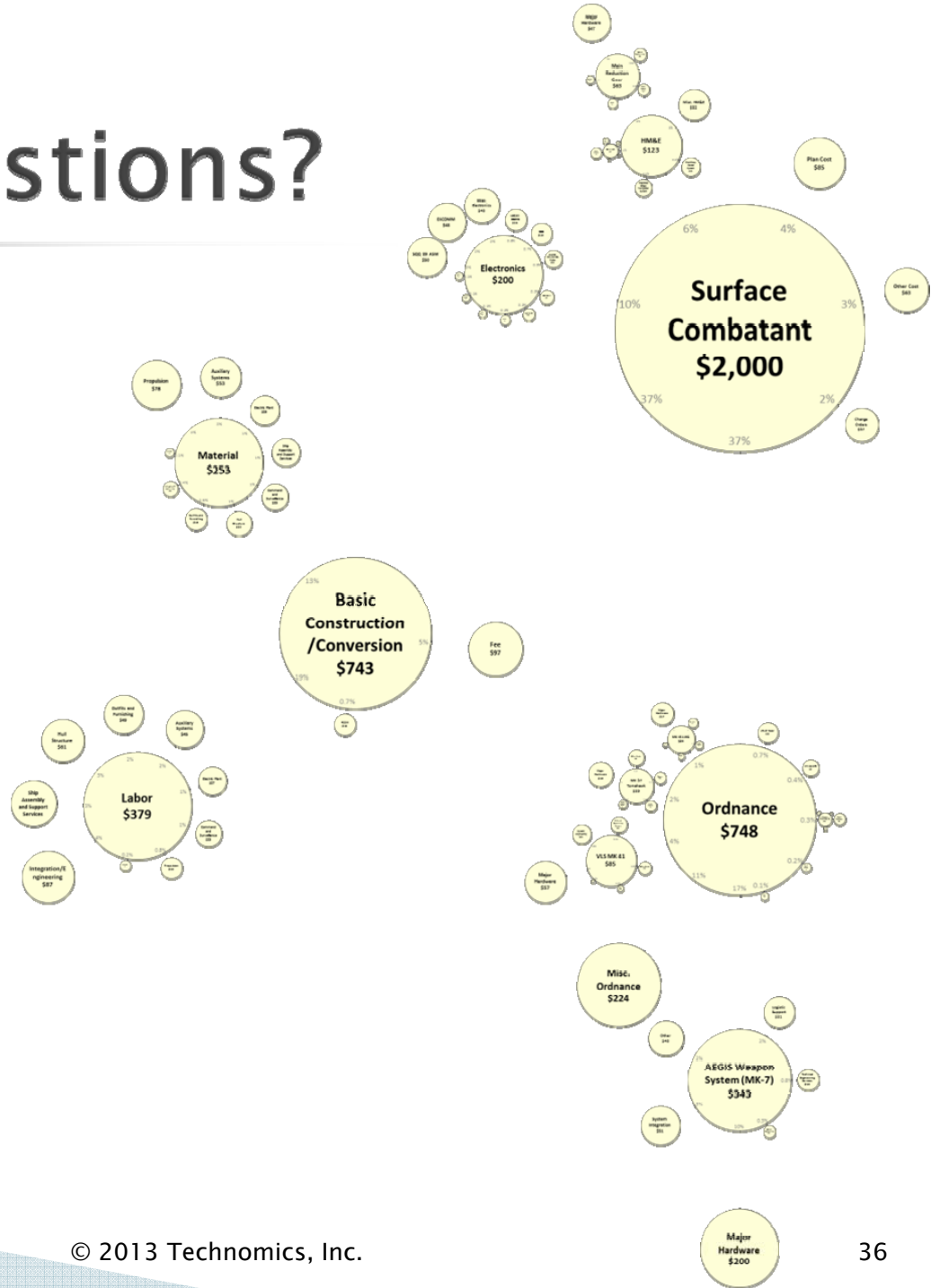
Questions?

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571-366-1412

Generate your own for free at www.galaxycharts.com





Applications Beyond Cost

- ▶ FY11 Federal Budget
- ▶ American Time Use
- ▶ Olympic Medals



Broad applications beyond Cost Analysis



Federal Budget

- ▶ Source: www.whitehouse.gov
- ▶ Grouped by major functions and subfunction
 - Major functions less than 1% grouped into "Other"

