1 Presentation
The Future of Project Controls, Cost Engineering and Project Management Offices (PMO)

GIAMMALVO, Paul D Dr.

The Good, the Bad and the Ugly…

Bio of expositor

Dr. Paul D. Giammalvo, CDT, CCE, MScPM, MRICS, GPM-M





Construction Documents Technician (CDT)
FORMER Certified Cost Engineer (CCE) #1240
FORMER Project Management Professional (PMP) #740
Master Green Project Manager (GPM-M) #002
Undergraduate Degree in Construction Management (honors)
Master Science, Project Management, GWU
PhD in Project/Program Management, ESC Lille, Lille, France

30+ years experience in Construction Project Management

20+ years working on large international projects:
- NCOIC Constructing Communications Sites, 52nd Signal Battalion, Vietnam 1968-69
- Negev Airbase Constructors, Ovda Israel (Camp David Peace Accords)
- Alyeska Pipeline, Valdez Alaska
- DEW Line Site Upgrades, Dead Horse, Alaska
- Caltex Pacific Indonesia, Sumatra
- Taman Rasuna Apartment Complex, Jakarta
- Tsunami Rebuilding Effort, Aceh, INDONESIA
- GSM/CDMA Tower Inspections, Nokia and Siemens, Indonesia

Senior Technical Advisor, PT Mitratata Citragraha, (PTMC) representing the ASEAN Project Manager's Center of Excellence Program (APMX)
Past Board of Directors, American Society of Project Managers (asapm)
Past Certification Board Chair, Green Project Management Organization (GPM)
Competency Credentialing Consultant to Guild of Project Controls

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Today's REALITY…

Associated Press March 4, 2009

msnbc — Search America's #1 News Site — MSN Home | Mail
featuring Today Show | Nightly News | Dateline | Meet the Press
Technology & science / space

Cost overruns plague U.S. space agency

GAO report used NASA as poster child for bad practices in estimating costs

"WASHINGTON - NASA can land a spacecraft on a peanut-shaped asteroid 150 million miles away, ***but it doesn't come close to hitting the budget target for building its spacecraft***, according to congressional auditors. ***NASA's top officials know it and even joke about it."***

Unfortunately for us, this is NOT News . . .
NASA has a long history of bad cost and schedule estimates . . . and Congress doesn't appear to be in a joking mood any longer.

Glenn Butts, NASA https://is.gd/E610OJ
Prof. Bent Flyvbjerg Oxford University - https://is.gd/3lJBEo AND https://is.gd/jHqivx

More REALITY…

Not Limited to NASA
Cost Overrun Everywhere . . . WHY???

A "Worldwide phenomenon that affects both the private and public sectors."
Green Book - English Government

TMCnews
[March 12, 2009]
US: Big defense programs face cost overruns
(Associated Press WorldStream Via Acquire Media NewsEdge) WASHINGTON_Costs are likely to keep growing for two of the Pentagon's biggest weapons programs as the military pushes to technology

2010 Olympic village construction cost overruns worry critics

DoD Faulted for JSF Cost Overruns
February 04, 2009
Fort Worth Star-Telegram
The Pentagon's top weapons buyer says the massive cost increases and delays incurred on the F-35 joint strike fighter program were inevitable because the Defense Department didn't spend enough money up fro to build realistic prototypes.

$14.6 billion later, Boston's Big Dig wraps up
The last big highway section opens this weekend, but concerns on costs dampen party.
By Seth Stern | *Staff writer of The Christian Science Monitor*
BENEATH BOSTON –
With a tellingly simple ribbon-cutting ceremony, the last underground segment of Boston's Big Dig project opens Friday - completing major construction on one of the most complex and controversial engineering projects in human history.

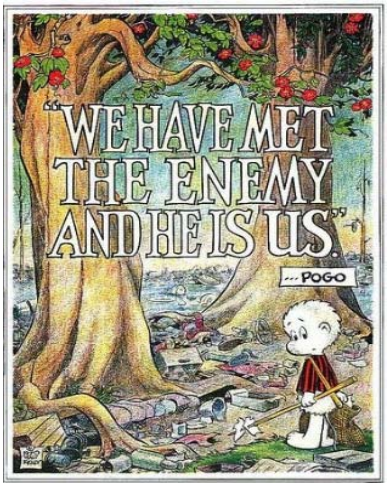
"Confidential project documents from 1995 reveal Bechtel ***willingly hid costs*** **to present a more favorable view of Big Dig's financial picture** at the behest of top state officials seeking a more publicly acceptable bottom line."
Source - Boston Globe

Glenn Butts, NASA https://is.gd/E610OJ
Prof. Bent Flyvbjerg Oxford University - https://is.gd/3lJBEo

The ROOT CAUSES…

Glenn Butts, NASA https://is.gd/E610OJ

Prof. Bent Flyvbjerg Oxford University - https://is.gd/3lJBEo AND https://is.gd/jHqivx



How Do We Underestimate?

- Let Me Count The Ways -

1. **OMIT PROBABLE SCOPE from estimate**
2. **OMIT POSSIBLE RISKS from analysis**
   - Internal & External
3. **UNREALISTIC, OPTIMISTIC assumptions**

} **RAND Study – Reason for 74% of Cost Growth**

4. **Use historically LOW ESCALATION projections**
   - RAND Study – Reason for 11.2% of Cost Growth
5. **Issue cost estimates in BASE YEAR dollars**
   - Estimates should be in then year dollars (escalated to year in which it is spent)
6. **Many estimates NOT PREPARED BY A BONA FIDE ESTIMATOR**
   - Everyone's a estimator
   - Being certified no guarantee of having necessary experience
7. **REWARD failure, PUNISH honesty**
8. **NOT ENOUGH TIME to prepare CREDIBLE estimates**
   - Time often spent doing "what if" exercises, or splitting dollars into arbitrary buckets

"I reject a system that rewards failure and protects a person from its consequences"

- Barack Obama -

Today's Agenda:
What are the TECHNOLOGIES impacting our craft?

1) **Building Information Modelling (BIM)**
   - **Automatically links the design software to generate Quantify Take offs and Bill of Materials into Cost Estimating software (i.e. Cost(OS), Timberline etc.) producing direct and indirect cost and resource loaded extensions.**
   - **Automatically links the 3D design software to generate the activities and sequencing in the planning & scheduling software (i.e. P6, MSP, Spyder, MicroPlanner etc.)**
   - **Enable "Front End Loading" (FEL) and Asset Life Cycle modeling, including Business Case (BEA, ROI, ROA, ERR, IRR) analysis, Life Cycle Costing, Value Engineering etc.**

2) **Drones, Time Lapse Photography and Facial Recognition**
   - **Attendance/payroll tracking and activity based costing (ABC)**
   - **Productivity capture**
   - **Progress tracking, documentation and reporting**
   - **Claims documentation**
   - **Safety, Health and Environmental violations**

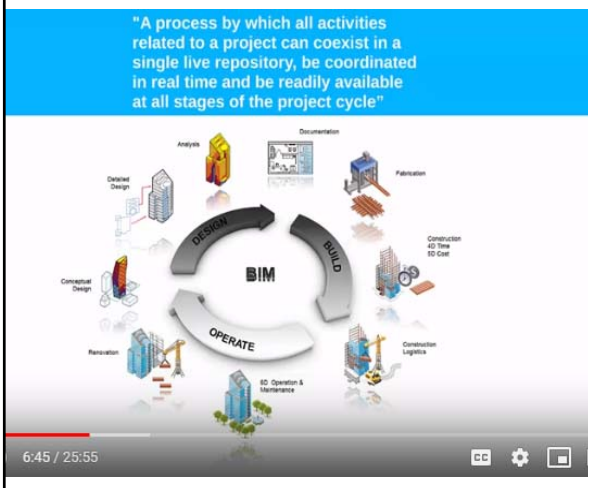
3) **Artificial Intelligence (AI) and "Big Data Analytics". If a process is:**
   - **Repetitious**
   - **Rule or formula based**
   - **Subject to conditional (Boolean) operators then is it probably going to be automated.**

What is "BIM" and what IMPACT it will have on "Project Controls"…?

1D	2D	3D	4D	5D	6D
SCRATCH POINT	VECTOR	SHAPE	TIME	COST	PERFORMANCE
RESEARCH -EXISTING CONDITIONS -REGULATIONS -WEATHER SIMULATIONS -SUN ORIENTATION -FUNCTIONAL PROGRAM	PRODUCTION -2D DRAWINGS -DOCUMENTATION -VIEWS AND PLANS	REPRESENTATION -RENDERINGS -WALKTHROUGHS -LASER SCANNING	PRODUCTION -MODEL FEDERATION -VIRTUAL CONSTRUCTION -SCHEDULING -PROJECT PHASING -TIME LINING -CONSTRUCTION PLANNING -EQUIPMENT DELIVERIES -VISUAL VALIDATION	PRODUCTION -QUANTITY EXTRACTIONS -DETAILED BILL OF QUANTITIES -FABRICATION MODELS	RESULTS -KNOWN ALTERNATIVES -CERTIFICATION -AUDITED BIM MODEL -PERFORMANCE REPORT
IMPLEMENTATION -CONSULTING -BIM EXECUTION PLAN -SERVER REPOSITORY -SOFTWARE	IMPLEMENTATION -PROGRAMMING -PARAMETERIZATION -FILE MANAGEMENT -COMMUNICATIONS	IMPLEMENTATION -BIM OBJECT CREATION -VISUAL PROGRAMMING -CLASH DETECTION -MODELCHECKER	SYSTEMS -PREFABRICATION -STRUCTURAL CONSTRUCTION -MEP CONSTRUCTION	CONTRACTS -FEES COMPARISON -TRADE SELECTION -LOGISTICS	VALUE ENGINEERING -SIMULATIONS -ENERGY PERFORMANCE -SYSTEMS PERFORMCE -ARCHITECTURAL PERFORMANCE -CONSTRUCTION PERFORMCE
CONCEPT DESIGN -STRATEGIES -AREA ESTIMATION -COST ESTIMATION -GENERAL VOLUMETRY -ACCESIBILITY -VIABILITY	DS DEVELOPMENT -ROOM DATA SHEETS -LIST OF DELIVERABLES -SCOPE DEFINITION -MATERIALS -STRUCTURAL LOADS -ENERGY LOADS	FINAL DOCS -DETAILED DESIGN -ASSEMBLIES -STRUCTURAL DESIGN -MEP DESIGN -SPECIFICATIONS	SIMULATIONS -LIFE CYCLE SIMULATION -SUN SIMULATIONS -WIND SIMULATIONS -ENERGY SIMULATIONS -CERTIFICATION CHECK	SUSTAINABILITY -CERTIFICATION EVALUATION -LIFE CYCLE COST -COMPARATIVE STUDY	SAVE ESTIMATION -COMPARATIVE COST -CONSTRUCTION BENEFITS -RETURN ON INVESTIMENT -TIMING RISK -SELECTED ITEMS TO BE OPTIMIZED
	SUSTAINABILITY -LIFE CYCLE ESTIMATION -CONSTRUCTION SOLUTIONS -PRIMARY MEP SYSTEMS -ENERGY PRODUCTION -CERTIFICATION STRATEGIES	SUSTAINABILITY -INSOLATION VALUES -SUN PROTECTION -DAYLIGHT REQUIREMENTS			RE-DESIGN -CERTIFIED BIM MODEL

BIM6 Consulting & Performance http://bim6d.es/en/scope/

What is "BIM" and what IMPACT it will have on "Project Controls"…?

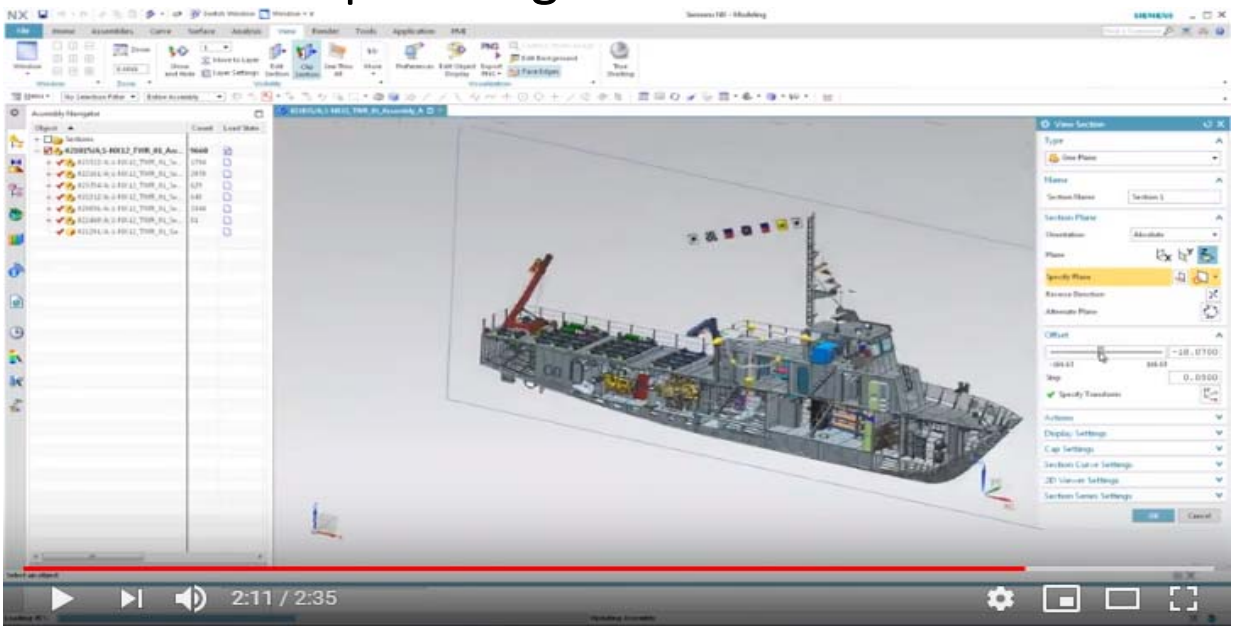


Unlocking the potential of BIM and virtual reality- https://www.youtube.com/watch?v=K6AbzBcQFyM

Global BIM Regulation Evolution

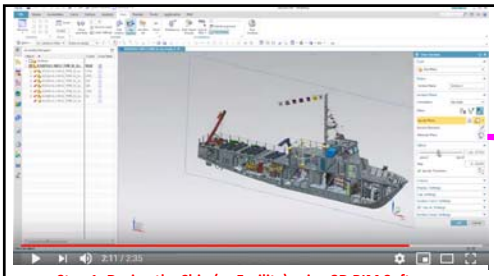
BIM Adoption Around the World- https://www.geospatialworld.net/article/bim-adoption-around-the-world-how-good-are-we/

3D BIM for Shipbuilding…



Step 1- Design the Ship (or Facility) using 3D BIM Software- https://www.youtube.com/watch?v=fBbX8IqJAjY

BIM Process…



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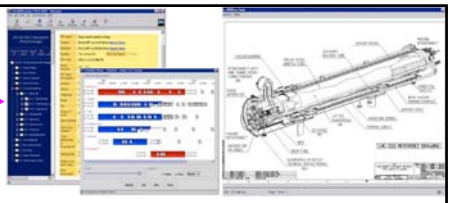
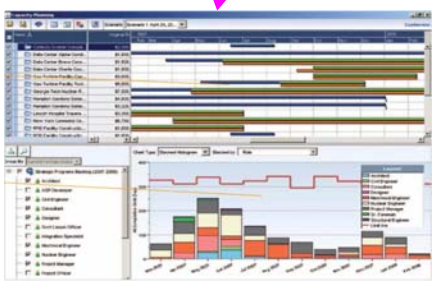
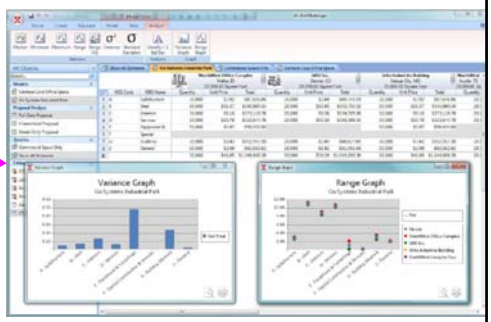


Step 2B - Document Management Software 3D BIM
http://e-specs.com/products/especs-revit/



Step 2A- Scheduling Software 4D BIM
https://www.youtube.com/watch?v=3JLUKUG1njU



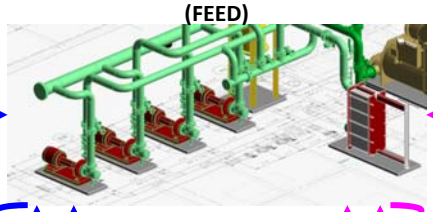
Step 2C- Cost Estimating Software 5D BIM
https://www.nomitech.eu/

Object Oriented Design Using 3D, 4D and 5D BIM…

Option 1- Pump A

Technical Specifications
Life Cycle Costing
Initial Costs
Procurement Lead Time
Installation Costs
Installation Duration
EVM Milestone Payments
Testing & Commissioning
Maintenance Requirements
Warranties & Guarantees
Operating Manuals

Front End Engineering & Design (FEED)



Schedule Impacts

Cost Impacts

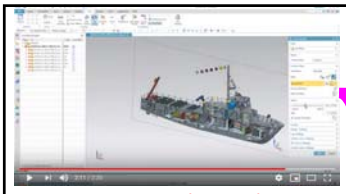
Cost vs Time Trade-Offs

Option 2 - Pump B

Technical Specifications
Life Cycle Costing
Initial Costs
Procurement Lead Time
Installation Costs
Installation Duration
EVM Milestone Payments
Testing & Commissioning
Maintenance Requirements
Warranties & Guarantees
Operating Manuals

Cost vs Time Trade-Offs

BIM Risk Analysis Process…



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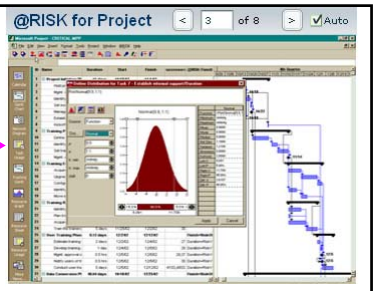
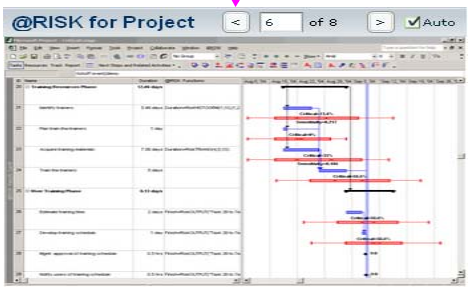
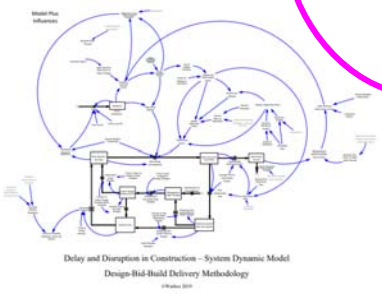


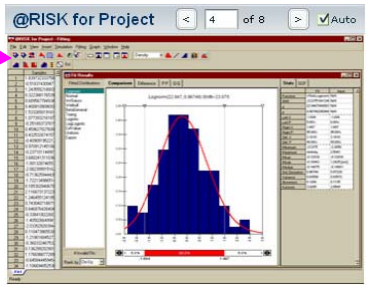
3) Establish the shape of the distribution (i.e. Normal, Raybull, Poisson etc)



4) Run the simulation using the Monte Carlo Random Number Generator for Schedule and Costs

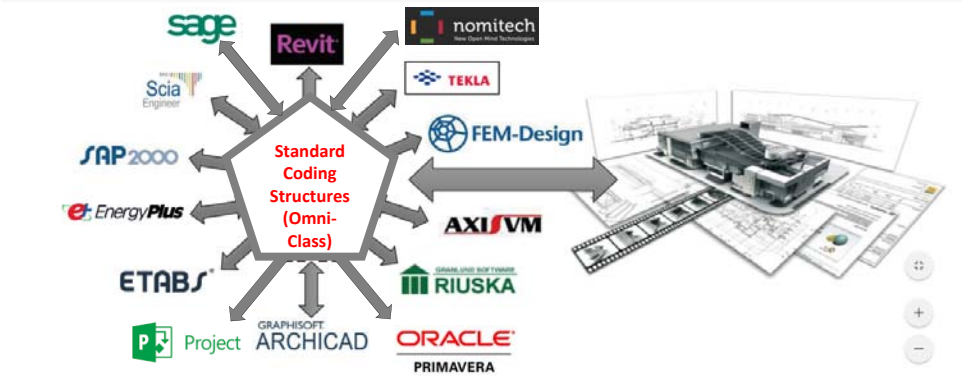


6) Create Systems Dynamics Model



5) Analyze the Results and Make Appropriate Strategic and Tactical Decisions

BIM REQUIRES the adoption of GLOBALLY STANDARDIZED Coding Structures



The databases for all these software packages REQUIRE the use of

STANDARDIZED WBS/CBS and other coding structures.

The most LIKELY "Leader" being OMNICLASS

https://www.csiresources.org/standards/omniclass

PMO WBS & CBS Coding Structures as ENABLERS for BIM

https://www.csiresources.org/standards/omniclass

Basis for BIDDING purposes (Owner's Level 3 Control Accounts)

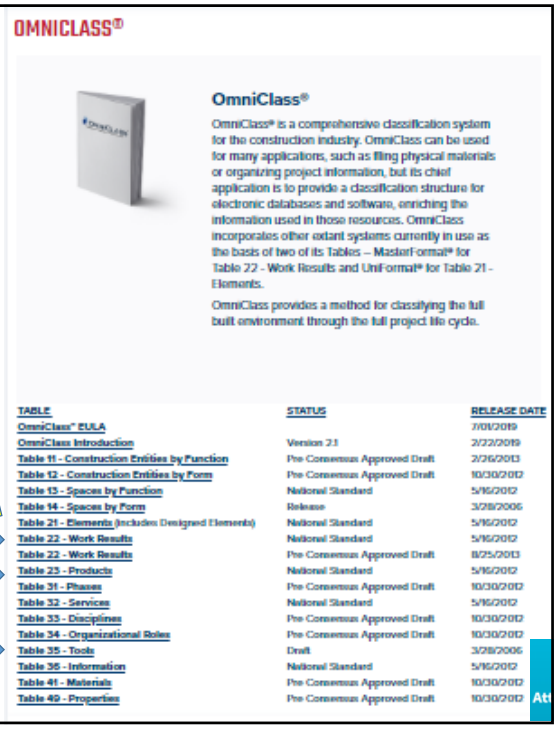
4 → Table 21- Elements

Basis for Progress Tracking, Cost and Revenue Capture (EVM) and Estimating Database Updates. (Level 4 Data Exchange between Owner and Contractor)

1 Table 22- Work Results

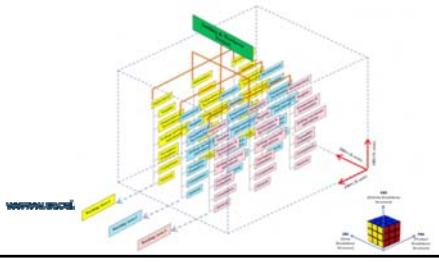
2 Table 23- Products

3 Table 35- Tools



Original STANDARDIZED MULTI-DIMENSIONAL WBS Structures

https://www.edmca.com/media/35207/masterformat-2016.pdf



Uniformat Basic Organization

UniFormat classifies information into the following nine Level 1 elements:

INTRODUCTION

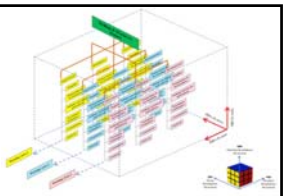
A	SUBSTRUCTURE	E	EQUIPMENT AND FURNISHINGS
B	SHELL	F	SPECIAL CONSTRUCTION AND DEMOLITION
C	INTERIORS	G	BUILDING SITEWORK
D	SERVICES	Z	GENERAL

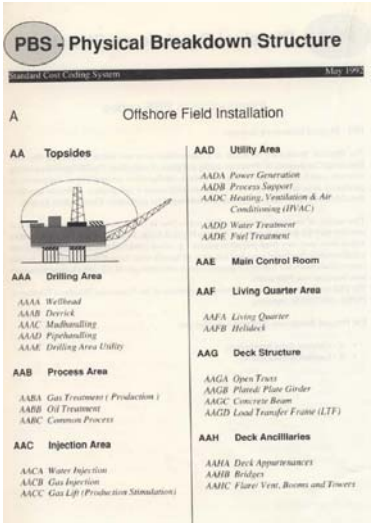
A	SUBSTRUCTURE	Level 1
A10	Foundations	Level 2
A1010	Standard Foundations	Level 3
A1010.10	Wall Foundations	Level 4
A1010.10.CF	Continuous Footings	Level 5

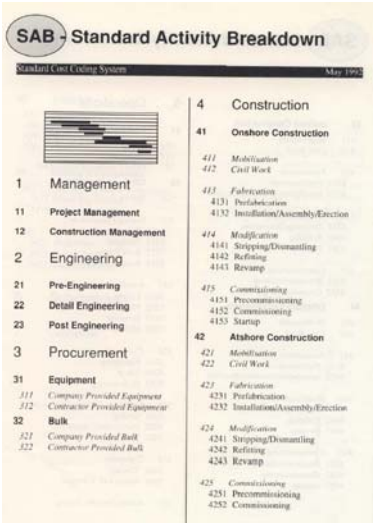
https://graphisoft.akamaized.net/cdn/ftp/techsupport/downloads/interoperability/UniFormat_2010m.pdf

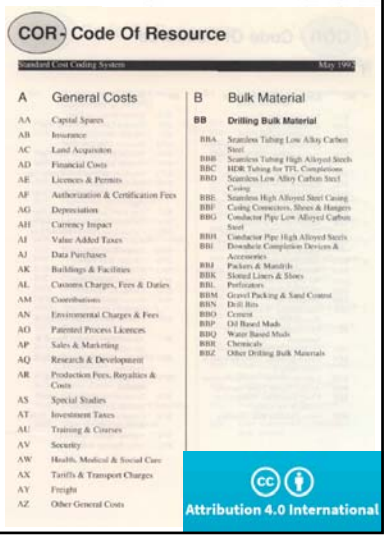
Norsok Z-014 OFFSHORE Platform Standardized WBS/CBS

https://www.standard.no/pagefiles/951/z-014.pdf

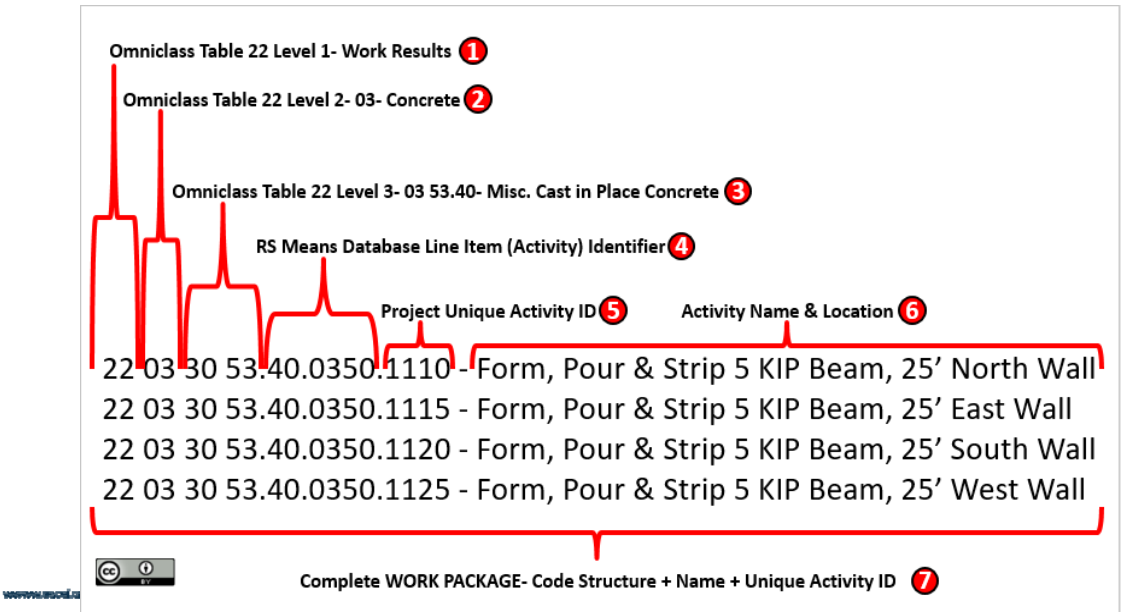








Introduction to the Levels of CODING STRUCTURES



Standard Activities from Cost Estimating Database (RS Means)

03 Concrete 1										
03 30 Cast in Place Concrete 2										
03 30 53 Miscellaneous Cast in Place Concrete 3										
03 30 53.40 Concrete in Place 4										
0.0010 0.0020 0.0050	Including Forms (4 uses), reinforcing steel, concrete placement and finishing, unless otherwise indicated.	Crew Type	Daily Output per Unit	Labor Hours per Unit	Unit of Measure	Material Costs	Labor Costs	Equip-ment Costs	Total Costs per Unit	Total Price/Unit Including OH&P
0.0300	Beams- 5 kip per lineal foot, 10' long spans	C14-A	15.62	12.8	Cubic Yard (CY)	$340.00	$645.00	$58.00	$1,043	$1,475
0.0350	Beams- 5 kip per lineal foot, 25' long spans	"	18.55	10.78	CY	$355.00	$545.00	$49.00	$949	$1,325
5		6	7	8	9	10	11	12	13	14

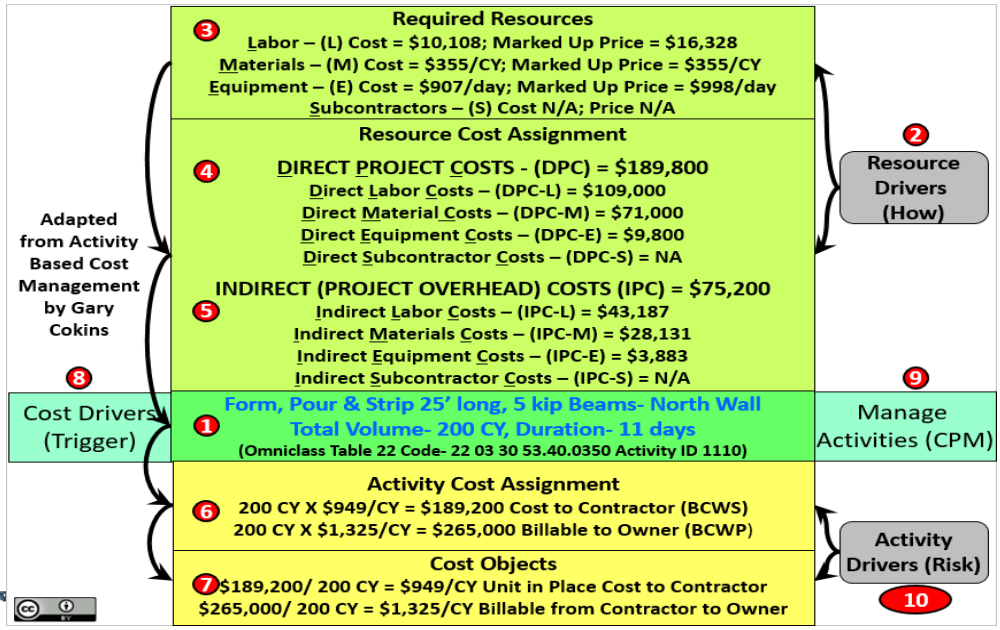
Source- RS Means Facilities Construction Costs 2018- Page 99

Standard Crews from Cost Estimating Database (RS Means)

#	Crew C-14A (1)	Contractors Bare Costs		Including Contractors OH & P		Contractors Crew Cost Per Labor Hour	
		Hourly (3)	Daily (4)	Hourly (6)	Daily (7)	Bare Costs (9)	Billing Rate Including OH & P
1	Carpenter Foreman	$52.70	$421.60	$85.55	$684.40	$50.54	$81.64
16	Carpenters	$50.70	$6,489.60	$82.30	$10,534.40		(12)
4	Rodmen	$54.65	$1,748.80	$87.30	$2,793.60		
2	Laborers	$39.85	$637.60	$64.70	$1,035.20		
1	Cement Finisher	$47.55	$380.40	$75.20	$601.60		
1	Equipment Operator	$53.75	$430.00	$84.80	$678.40		
1	Gas Engine Vibrator		$25.60		$28.16	(10)	(13)
1	Concrete Pump (Small)		$881.60		$969.76	$4.54	$4.99
200	Total Daily Labor Hours		$11,015.20		$17,325.52	$55.08	$86.63
(2)			(5)		(8)	(11)	(14)

RS Means Facilities Construction Costs 2018- Page 1400

Activity Based Costing Using Example from RS Means

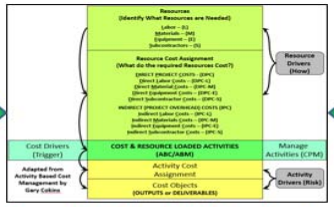


"Big Picture" Roadmap…

	Account Title	Account #	Balance
2	Assets	1	Dr
40	Liabilities	2	(Cr)
69	Equity	3	(Cr)
96	Revenue	4	(Cr)
113	Expenses	5	Dr
114	Expenses Classified By Function	5.1	Dr
115	Cost Of Revenue	5.1.1	Dr
116	Cost Of Goods Sold	5.1.1.1	Dr
117	Cost Of Services Rendered	5.1.1.2	Dr
118	Other Costs Of Sales	5.1.1.3	Dr
119	Selling, General, Administrative	5.1.2	Dr
120	Selling And Marketing	5.1.2.1	Dr
121	General, Administrative Expenses	5.1.2.2	Dr
122	Other Operating Expenses	5.1.2.3	Dr
123	Doubtful Accounts	5.1.3	Dr
124	Expenses Classified By Nature	5.2	Dr
125	Merchandise, Material, Supplies And Utilities	5.2.1	Dr
126	Employee Benefits	5.2.2	Dr
127	Services	5.2.3	Dr
128	Rent, Depreciation, Amortization And Depletion	5.2.4	Dr
129	Taxes And Fees	5.2.5	Dr
130	Other Expenses	5.2.6	Dr
131	Other Revenue, Expenses, Gains And Losses	6	Dr / (Cr)
148	Income Tax (Benefit)	7	Dr / (Cr)

"How to get these two STANDARDIZED CODING STRUCTURES mapped to one another so they can EXCHANGE DATA between the ERP, CPM Scheduling (4D BIM), Cost Estimating (5D BIM) and other BIM systems?" (i.e. 6D & 7D BIM)

ABC/ABM

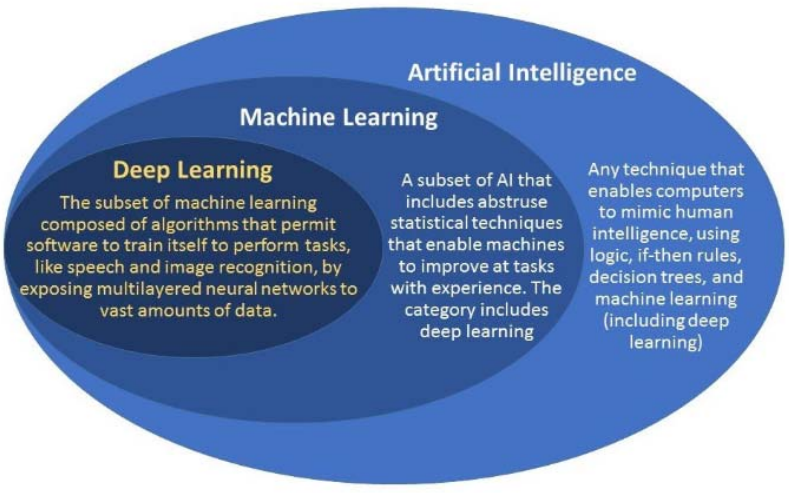


ABC/ABM

By adopting Activity Based Costing (ABC) as the basis for the Cost Baseline and Activity Based Management (ABM) and Earned Value Management as the basis to Manage the Project and capture both costs and revenues in the ERP System.

What is Artificial Intelligence or "AI"?

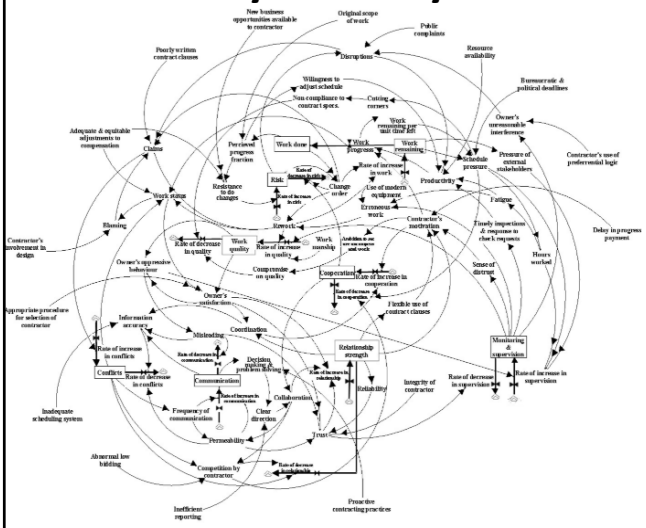
7° Congreso AACE International de Ingeniería de Costos | AACE PERU

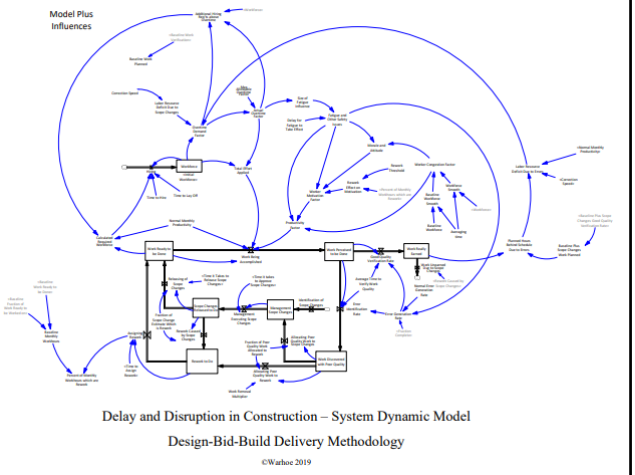


https://www.geospatialworld.net/blogs/difference-between-ai%EF%BB%BF-machine-learning-and-deep-learning/

www.aacci.org.pe

Systems Dynamics Replacing MSP and P6?





Kamran & Kusumo, 2018 (AIT-Thailand) Model of O/C relationships https://ascelibrary.org/doi/10.1061/%28ASCE%29ME.1943-5479.0000666

Modeling Productivity Loss Using System Dynamics to Understand Cumulative Impact Dr. Stephen P. Warhoe, PE CCP CFCC

Use of Artificial/Machine Intelligence for "Project Controls"

https://www.youtube.com/watch?v=FTtVxxCSYHE

https://goo.gl/hffzsg

https://ligchine.com/screedsaver-max-200-machine

https://www.trafficandtransit.com/mega-ton-girder-placement-over-la-jolla-village-drive-san-diego

Use of Time Lapse Photography for "Project Controls"

https://www.youtube.com/watch?v=ptZmvz6YRuY

https://www.youtube.com/watch?v=GDUIYZKlknk

https://www.youtube.com/watch?v=acLSbNxUP3s

Use of Drones for "Project Controls" …

3D Progress Reporting

2D Progress Reporting

Volume Calculations

https://www.youtube.com/watch?v=Tm3NXhGLvuU
AND
https://www.youtube.com/watch?v=i3V2L1XHZcA

Use of Facial Recognition for "Project Controls"

https://gizmodo.com/this-facial-recognition-software-signals-the-end-of-the-1548210294

https://www.youtube.com/watch?v=K4u4Dpl6NKk

Project Management is NOT WORKING

Stairway to Success

1. Benchmarking
- Benchmark against your own previous projects, your peers, industry, and best practice
- Know your own uncertainty and risks
- Improve resource allocation, eliminate knock-on effects

2. Due Diligence
- Scrutinize your own and your forecasters' planning
- Know how likely estimated costs, benefits, and schedules are to actually materialize
- Quantify project viability in different scenarios
- Flyvbjerg, "Quality Control and Due Diligence…", *IJPM*, 2013

3. Reference Class Forecasting
- Reduce front-end bias of projects
- Identify and eliminate
  - Delusion
  - Deceptions
  - Black Swan Blindness
- Quantify unknown-unknowns
- Align incentives
- Flyvbjerg, "From Nobel Prize to Project Management", *PMJ*, 2006

4. Black Swan Management
- Think carefully about reducing scale (physical and especially temporal)
- Identify anti-fragilities
- Reduce technical and social complexity
- Flyvbjerg & Budzier, "Why Your IT Project Might Be Riskier Than You Think", *HBR*, 2012

5. Masterbuilder Leadership
- Learn from master builders, i.e., project managers with proven track record of building on time, on budget, and on benefits
- What are their heuristics?
- What are their programmatics?
- Improve your leadership; grow Master Builders in your organisation

The Good, the Bad and the Ugly…

The Good News is-

We have a little time to prepare for the transition and there are some really great opportunities to exploit both short and mid term.

- Practitioners need to learn how to ADAPT traditional "cost engineering" and "project control" tools, techniques and methodology's, as many will still be manually operated and controlled as we transition over the coming 5-10 years.
- We need to become MUCH more actively involved in creating the coding structures and underlying cost, productivity, duration and supporting databases. (i.e. RS Means, Compass, Richardson's et al)
- The only real "bright spot" is, until the bugs are worked out, the claims people are likely to have a LOT of work!

The Bad News is-

The practice of "cost engineering" and "project controls" as is currently practiced is going to be profoundly impacted by BIM, AI and other technologies and certainly not in the "traditional" sense. PROBABLY much of what we do today will be gone or unrecognizable in 10 – 20 years, maybe even less. (The job title of "Quantity Surveyor" has already largely been made redundant by digitizers and now BIM)

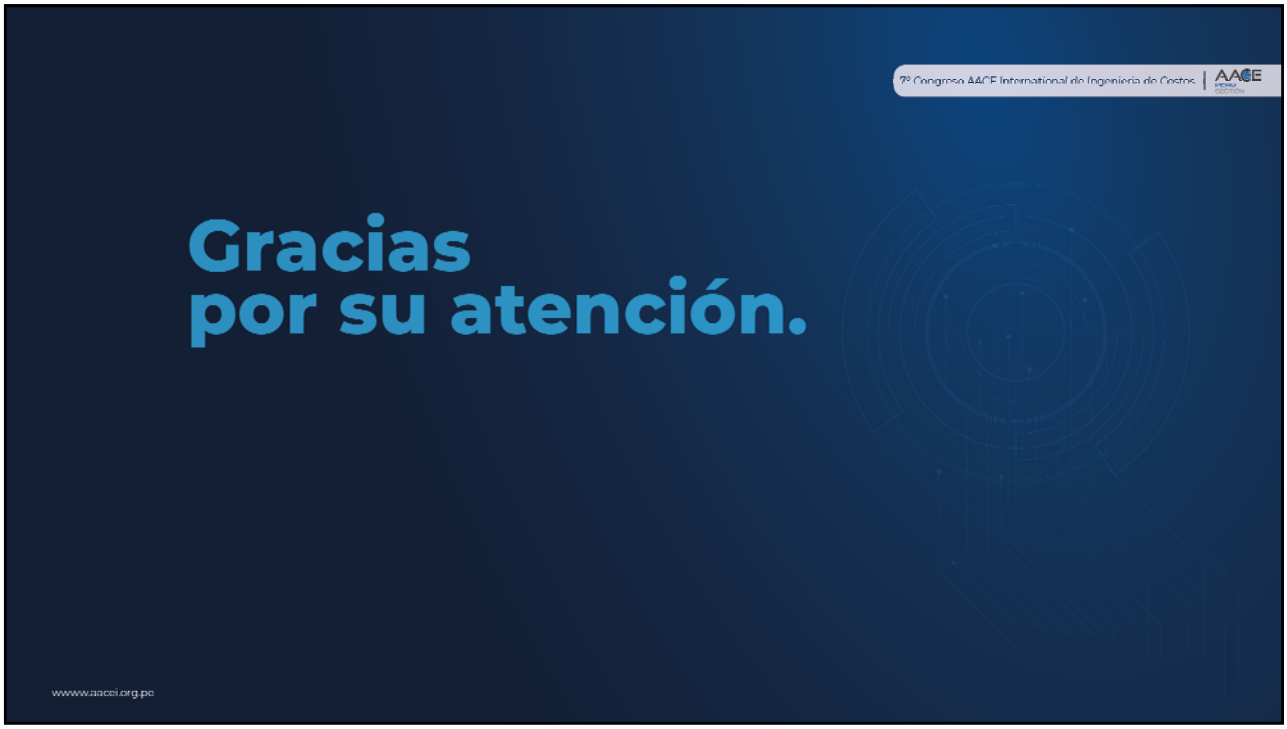
The Ugly News is-

Until/unless AACE/PMI et al are willing to recognize the inevitability of these changes and assume a more strategic leadership position we are unlikely to have any meaningful influence on or even inputs onto the transition into the future.

- AACE needs to IMMEDIATELY engage with ISO and CSI to work on developing the Omniclass Tables. There are many missing elements and if we fail to contribute we will be left behind.
- AACE needs to focus more on Database Development and Database Management in the TCMF and on the certifications
- AACE needs to drop the Single Dimensional WBS and start to recognize and accept that the single dimensional (flat file) coding structure is DEAD and the future is based around MULTI-DIMENSIONAL WBS/CBS coding structures designed for each stakeholder to see the project deliverables the way THEY need or want to see them presented.

Questions comments?

(Please use microphone)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Gracias
por su atención.
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