Big idea:

Integrated Concurrent Engineering (ICE) is a social method, helped by technology, to create and evaluate multi-discipline, multi-stakeholder VDC models extremely rapidly.
Overview

<table>
<thead>
<tr>
<th>Session</th>
<th>Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Concurrent Engineering (ICE):</td>
<td>Develop, show and explain the product, organization, process, POP and 4D models as well as analyses of each and recommendations for management based on the design exercise - collaboratively and quickly</td>
</tr>
</tbody>
</table>
Integrated Concurrent Engineering (ICE) Background

Given

- Objective = Rapid, effective design “extreme collaboration” (~1 week)
- Excellent VDC software
- Collocated team
- iRoom
- Good generic VDC project definition templates
- SD (DD) phase focus
The big ideas of ICE

• The Big Ideas:
• Exceptional performance, e.g., Team-X at NASA-JPL
• It works because it achieves exceptionally short information latency and short task durations, reliably.
• Multiple factors enable ICE to work.
Goals of this design session: 
*Project Definition (v)*

Define:

- What each of the teams expects to deliver
- What they expect from the other team members
- How can individuals coordinate their respective and collective scopes
- How team members know how work is progressing
- How team members know when (pre)construction is completed
- What work resources and methods can be used for (pre)construction work
- What resources and work methods will be used for the (pre)construction
Goals of this design session: Project Definition (v)

Define:

- What each of the teams expects to deliver (plans, commitments)
- What they expect from the other team members (commitments)
- How can individuals coordinate their respective and collective scopes (coordination commitments)
- How team members know how work is progressing (risks; measurable process performance metrics)
- How team members know when (pre)construction is completed (measurable outcomes)
- What work resources and methods can be used for (pre)construction work (controllable factors)
- What resources and work methods will be used for the (pre)construction (commitments)
Goals of this design session: 

*Project Definition (v)*

For the product, organization and process, project definition clarifies and aligns:

- **Functional objectives** – what project stakeholders want –
  - Specific deliverables, e.g., spaces, systems
  - Conforming and highly reliable safety, schedule, quality and cost

- **Scope** – “forms” you create -- periodic design and construction deliverables, including: designs of the
  - *Product* (~weekly or daily) – to update objectives, designed scope, predicted and measured behaviors
  - *Organization* – groups of people to do tasks that work on the design
  - Process (daily work) – tasks to design and manage, procure, fabricate, deliver, construct and inspect

- **Behaviors** – what you predict and what you did – predict and measure performance of designed scope
  - With respect to specific stakeholder objectives
  - Using methods of VDC, Integrated Project Delivery, Lean and Sustainable development
Potential value of VDC

- Better project or corporate performance (measurably)
  - Suggests need for ~weekly performance data: **specify >=2 metrics each for P, O, P**
- Better clarity of decision processes, for
  - Decision-makers
  - Execution team
  - Executive team
- Better plans and clear commitments for working team
- $\downarrow$ Rework; $\downarrow$ Work effort $\Rightarrow$
  $\uparrow$ Profitability, $\uparrow$ Business

VDC methods:
- Models: Product (3/4D), organization (commitments), process (plan, schedule)
- Collaboration methods: ICE
- Analyses (model-based): Clash, Structure, QTO, cost, energy, …
- **Metrics:** Outcome, process, controllable factors
Integrated Concurrent Engineering (ICE)

Product – Organization – Process (POP) Model

format:

A POP model has the format below:

<table>
<thead>
<tr>
<th></th>
<th>Function: Objectives</th>
<th>Form/Scope: Design choices</th>
<th>Behavior: predictions</th>
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<tbody>
<tr>
<td><strong>Product</strong></td>
<td>spaces, elements and</td>
<td>Designed spaces, elements</td>
<td>Predicted cost ($)</td>
</tr>
<tr>
<td></td>
<td>systems</td>
<td>and systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measurable Objectives</td>
<td>Values</td>
<td>Predictions; Assessed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>values</td>
</tr>
<tr>
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<td>Selected actors</td>
<td>Predicted cost (hours</td>
</tr>
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<td>or $)</td>
</tr>
<tr>
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<td></td>
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<td>Values</td>
<td>or $)</td>
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Process of Project Definition

- Build VDC project definition templates as a stakeholder team
  - Set *functions* (objectives) of Product, Organization, Process
  - Design *form or scope* of Product, Organization, Process
  - Identify project *behaviors* and define methods to predict, assess and observe them

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## Virtual Design and Construction (VDC) vs. Building Information Modeling (BIM)

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<tbody>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
| spaces, elements and systems | Designed spaces, elements and systems | Predicted cost ($)
| Measurable Objectives | Values                      | Predictions; Assessed values |
| **Organization**     |                             |                       |
| Actors               | Selected actors             | Predicted cost (hours or $)
| Measurable Objectives | Values                      | Predictions; Assessed values |
| **Process**          |                             |                       |
| Tasks                | Designed tasks              | Predicted cost (days or $)
| Measurable Objectives | Values                      | Predictions; Assessed values |

**VDC**

**BIM**

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<tr>
<td><strong>Product</strong></td>
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</tbody>
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| **Process**          |                             |                       |
| Tasks                | Designed tasks              | = Empty =              |
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Integrated Concurrent Engineering at JPL (ICE)

Properties

• Collocated Organization (Closed Knowledge Network)
• Excellent Technical Infrastructure
• Formal Objective Metrics
• Informal Process and Culture

Photo thanks to JPL
Integrated Collaborative Engineering (ICE) at CIFE

- Collocated Organization (Closed Knowledge Network)
- Excellent Technical Infrastructure
- Formal Objective Metrics
- Informal Process and Culture
Without Integrated Concurrent Engineering

Source: @ammunition group: [http://twitpic.com/5xs1vy](http://twitpic.com/5xs1vy)
Observations

ICE at NASA-JPL characteristics

- Organization: Multiple stations (~18)
- Process: careful design
- Technology:
  - Multiple shared display screens
  - Shared database (Icemaker)
Coordination Latency is the fundamental performance metric for knowledge work

- **Response latency** = Time from a designer posing a question to receipt of a useful answer
- **Decision latency** = Time from receiving useful information to making a decision with it

- Good engineering practice for both: 2 days
  - weeks typical
- Why it is important: non value-adding time
- **Measurable ICE Objective for latency: minutes, reliably**
  - For and as assessed by all intended stakeholders
Simple analysis of Latency

Traditional

• Project requires
  ▪ 100 “queries” per engineer @ Latency = 2 days (good!)
  ▪ 100 modeling, analysis, meeting “tasks” @ task durations < 2 days

➢ Project duration ~ 200 calendar days (typical)
➢ Latency paces schedule (typical)
  ▪ Not direct work

ICE (Team-X)

• Project requires
  ▪ 100 “queries” per engineer @ Latency = 1 minute
  ▪ 100 modeling, analysis, sidebar “tasks” @ task durations ~8 minutes

➢ Project duration ~ 2 calendar days (Team-X)
➢ Direct work (modeling + analysis + documentation) paces schedule (Team-X),
  ▪ Not coordination latency
ICE requires latency management

- Latency extends schedules
  - Interdependent tasks have incessant information requests
  - Requests have response delays (latency)
  - Latency adds no value, measures collaborative waste
- Integrated Concurrent Engineering dramatically cuts time and latency
  - Reduces latency from days to minutes
  - Direct work tasks must run in minutes
  - Enables radically decreased project duration
  - Researchers, practitioners report improved cost, quality
  - Requires high reliability (> 99%) latency: one major latency source jeopardizes project success
  - New organizational form
How ICE (Team-X) works

Manages:
1. **Duration of direct work tasks**
   - Model, describe, predict, explain, evaluate, generate alternatives, decide
   - Requires highly skilled engineers with excellent tools that they know well and culture that provides good enough answers
2. **Coordination Latency**
   - Time for a designer to obtain usable information
   - Requires many enabling factors

Supports both:
1. Associative (divergent) thinking
   - *Many* options, intuitive, including unique idea
   → Fluency (lots of options), Flexibility (different kinds), Original (at least one)
2. Analytical (convergent) thinking
   → data, prediction, analysis, evaluation and recommendations that believably support decision-making
   - Actionable
Ling on “Taking for grantedness” [1]

• We take some things for granted
  – Calendar, clocks (and time and time zones), cell phones
  – We make (generally similar) assumptions about what we will (and expect others to do) to use things that we take for granted

• Ling’s steps toward “taking for grantedness”
  1. Diffusion
  2. Legitimization
  3. Social ecology
  4. Reciprocal expectations

Implications of “taking ICE for granted”

• Implications of “taking ICE for granted”
  1. Diffusion – Professional development to bring ICE, BIM and metrics methods to the team
  2. Legitimization
     • Leadership to bring the method into practice
     • Early successes to create demand to use it
  3. Social ecology – fit ICE into the organization and the project development process: e.g., number of concurrent project assignments
  4. Reciprocal expectations of participants
4. Reciprocal expectations of participants:
   • Safety: participants feel that it is “ok” to participate actively
   • Session attendance: invitations, attendance
   • Session homework: participant level of preparation for sessions
   • Support for in-session availability of and change of BIMs, prediction tools, metrics and collaboration technologies
   • Latency during and outside of sessions
   • Decision stickiness
   • Rules of engagement and conflict management in ICE sessions
Methods to enable a project to “take ICE for granted”

- **Templates**
  - ICE pre-plan
  - Operations agreement
  - BIM (VDC project model) Content Specification

- **Deliverables**
  - Task and coordination commitments
Methods to enable a project to “take ICE for granted”

• Target values and performance metrics:
  – Intended stakeholder timely and meaningful engagement in ICE sessions
  – Latency: response and decision
  – Quality, cost, schedule, safety process and outcome performance
  – Individual and team preparation for sessions
Use ICE for Target value design for cost, schedule, energy, ...

- Generate and evaluate many design options w/ICE
- Select target cost
- Rapid design method: PIDO
  [Link](http://network.modelfrontier.eu/documentation/pido.html)

Assessed project value and predicted cost of many options

Wide design option space

Linear value curve
Use ICE for Target value design for cost, schedule, energy, ...

- Generate and evaluate many design options with ICE
- Select target cost

Assessed project value and predicted cost of many options

Non-Linear value curve
Use ICE for Target value design for cost, schedule, energy, ...

• Generate and evaluate many design options w/ICE
• Select target schedule

Assessed project value and predicted schedule of many options

Value

Low Schedule High

+ Δ

- Δ
Use ICE for multi-discipline target value design:

- When a change affects two measures of project success,
  - Choose when upside value exceeds downside risk
  - E.g., \(- \Delta \) cost risk
  - \(< + \Delta \) upside schedule compression value

“\(I\ can\ sell\ this\)”
## ICE Methods

### Normal Stations
- **Owner**
- **Product:** model functions, scope, behaviors
- **Organization:** model functions, scope, behaviors
- **Process:** model functions, scope, behaviors
- **Integrated project:** POP model
- **Facilitator (session leader)**
- **Project manager**

### Process
- All stations simultaneously develop model inputs
- Coordinate continuously
- Assess and evaluate first design option
- Deliver project:
  - Definition
  - Objective assessment
  - Option evaluation
Steps to perform ICE sessions...

- **Pre-planning:** a few days immediately prior to ICE sessions
  - Invite a very small set of project principals (2-4)
  - Do project definition and identify VDC project definition templates at Level-B with ~10 each of P, O, P elements

- **Determine the design space to explore in ICE session:**
  - Invite relevant stakeholders to ICE session
  - Select modeling and analysis tools and methods
    - Assure that facility and intended tools are available

- **ICE session:** ~3 sessions within one week
  - Frequent process checks (every ~20 minutes)

- **Post-session:** a few days immediately following ICE sessions to create formal deliverables
When to hold ICE sessions ... 

• For each major project phase
  – at least early (concept and schematic), detailed (DD, CD) and to plan construction

• Collaborating with your other stakeholders

• Hold a set of about 3 ICE sessions

• Build and analyze a project model for the next phase in enough detail to identify objectives, scope and predicted performance believably
Why to hold an ICE session

• Do project definition rapidly and believably
  – Define functional objectives, scope, behaviors of Project, i.e.,
    • Product, Organization, Process
• Clearly identify tasks and deliverables for next period (week or month)
  – Focus: product element and system(s) served
  – Who: responsible group, individuals
  – What: tasks to perform
  – When: according to broadly reviewed and accepted schedule
  – How: methods and resources to be used by responsible team(s)
    to coordinate, do work and verify work
  – Context: specific
    • risks and uncertainties to address based on broad project review
    • coordination tasks to assure success given risks
To plan a set of ICE sessions

• Enable effective use of ICE methods
  – Professional development of potential team members - create culture, methods, incentives
  – Implement enabling tools: P, O, P modeling and analysis applications, display technology, shared database

• Plan each set of ICE sessions: Identify
  – Objectives and intended deliverables: models, analyses, reports, recommendations, …
  – Number of sessions and calendar schedule: typically 2-4 over ~ 1 week
  – Intended participants, tasks for each session
  – Effort and time budgets for use of ICE sessions
  – Process performance metrics and methods: measured and assessed quality, schedule, cost
ICE deliverables …

• Functions: statement of project objectives for P, O, P

• Scope:
  – Design of multiple P, O, P options in large design space
  – P, O, P models for use by next phase

• Behaviors: predicted P, O, P performance

• Evaluation of acceptability of options given objectives

• Risk assessment and mitigation strategy

• Recommendation for new P, O, P design option(s)

• Proposed product design, team, schedule and responsibilities for next phase
# ICE vs. traditional meetings in construction

<table>
<thead>
<tr>
<th>Issue</th>
<th>ICE</th>
<th>Traditional meetings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome re issue at hand</td>
<td>Resolution</td>
<td>Tracking of status</td>
</tr>
<tr>
<td>Agenda management</td>
<td>Focused on clear, shared agenda</td>
<td>Tangents, pursuit of personal agendas</td>
</tr>
<tr>
<td>Description of problem and context</td>
<td>Shared and clear</td>
<td>Individual perceptions</td>
</tr>
<tr>
<td>Number of options considered</td>
<td>Multiple; consider what-ifs</td>
<td>Focused on agenda of one individual</td>
</tr>
<tr>
<td>Supporting technologies</td>
<td>Interactive visual models and analyses</td>
<td>Paper and appeal to understanding of others</td>
</tr>
</tbody>
</table>
# ICE Enabling Factors

<table>
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<th>(Committed) Organization</th>
<th>(Dynamic) Process</th>
<th>(Visual) Technology</th>
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<tbody>
<tr>
<td><strong>Stakeholders Present:</strong> (Closed knowledge network)</td>
<td>Processes clear: (low equivocality)</td>
<td>Excellent discipline-specific modeling, visualization tools</td>
</tr>
<tr>
<td><strong>Focused design staff:</strong> 100% committed in sessions</td>
<td>Processes distinct: High structure independence</td>
<td>Rich communications media</td>
</tr>
<tr>
<td><strong>Flat organization structure</strong></td>
<td>Resolve problems in small self-formed groups (<em>Pooled</em> communications)</td>
<td><em>Integrated</em> database</td>
</tr>
<tr>
<td><strong>Egalitarian culture</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High goal congruence</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Staff survey: Example of how senior management helps

1. I feel that I can challenge people at any level in my organization without fear.
2. I feel I can ask for and receive the resources (time, budget, equipment) I need to solve problems.
3. My Manager/Supervisor makes it easy to speak up when problems arise.
4. My Manager/Supervisor listens to bad news, yet still asks for unrealistic targets.
5. When we present bad news, our Manager/Supervisor repeatedly asks for more information focused on showing that the problem is not as bad as it seems.
6. My Manager/Supervisor encourages us to ask for help outside our organization or the chain of command (e.g., outside our project or work group or next level up) if we need it.
7. I am aware of what to do when a Manager/Supervisor doesn’t respond appropriately to bad news and it needs to be escalated to a higher level.
8. My team uses metrics and processes effectively (e.g., trend program, standard metrics, etc.) to analyze, surface & solve problems.
9. In my organization, we live by our corporate values
10. The formal metrics in my organization often do not convey an accurate picture of performance.
Organization Enabling factor: 
*Stakeholders Present:* (Closed knowledge network)

- **Objective:** knowledge and authority always present
- **Meaning:** Requisite knowledge, procedures, options, and authority are immediately available in the room (almost always)
- **Risk factors:** sidebars; unanswered sidebars
- **Team-X Methods:**
  - Heavy reliance on collaborative design sessions
  - Designer collocation during sessions
  - Careful participants selection and training
  - Pre-plan to identify needed participants
Organization Enabling factor: 
*Design staff focus*

- **Objective:** 100% available during meetings
- **Meaning:** Design session participants focus exclusively on project work during design sessions
- **Risk factors:** Designers have other responsibilities during design sessions, so team waits for expertise
- **Team-X Methods:**
  - Management support of focus
  - Short sessions enable managers to free valued staff
Organization Enabling factor: 
*Hierarchy structure*

- **Objective:** Flat
- **Meaning:** Minimal required decision-making structure and overhead
- **Risk factors:** Soliciting management approval challenges short latency
- **Team-X Methods:**
  - No managers
  - Culture of autonomy and respect
  - One facilitator (session leader)
Organization Enabling factor: *Egalitarian culture*

- **Objective:** Egalitarian
- **Meaning:** Positions assume empowered decision-making and low management overhead
- **Risk factors:** Soliciting management approval challenges short latency
- **Team-X Methods:**
  - Culture of autonomy and respect
  - Careful recruitment
  - Decisions and decision processes highly visible to all
Organization Enabling factor:

*Goal Congruence*

- **Objective:** Highly congruent
- **Meaning:** participants know and aspire to same goals and methods
- **Risk factors:** positions debate priorities or methods
- **Team-X Methods:**
  - Discuss goals and methods at session start
  - Facilitator (session leader) attention
  - Culture of congruence
  - Analysis and decisions very visible to all
Process Enabling factor: Processes clear: (low equivocality)

- **Objective**: design, coordination and construction processes clear
- **Meaning**: all participants understand and accept procedures, goals and objectives
  - Implies that method applies *only* to well-understood processes
- **Risk factors**: positions ask for and wait for facilitator (session leader) decisions
- **Team-X Methods**:
  - Use only for well-understood processes
    - Pre-plan for process clarity
    - Culture of autonomy
    - Analysis and decisions very visible to all
    - *Excellent process facilitator (session leader)*
Integrated Concurrent Engineering (ICE)

Process Enabling factor:
*Processes distinct*: (High structure independence)

- **Objective**: design processes clearly separated
- **Meaning**: Design tasks are distinct, positions all understand their responsibilities and can proceed with minimal management oversight
- **Risk factors**: positions solicit or wait for facilitator (session leader) decisions
- **Team-X Methods**:
  - Use only for projects that allow independence
  - Pre-plan for independence
  - Staff selection and training
  - Culture of autonomy
  - Analysis and decisions very visible to all
Process Enabling factor:
Resolve problems in small self-formed groups *(Pooled communications)*

- **Objective**: Pooled communications
- **Meaning**: Participants resolve problems in small self-formed groups
- **Risk factors**: Formal or inflexible coordination requirements
- **Team-X Methods**:
  - Collocation
  - Shared project (POP) model
  - Shared projection screens
  - Sidebar culture
Technology Enabling factor:  
Modeling, Visualization Tools

• Objective: Excellent
• Meaning: Discipline-specific tools allow all positions to do direct work very fast
• Risk factors: Manual design activities or poor tools bottleneck schedule; Other designers fail to understand a model
• Team-X Methods:
  – Modeling, visualization, analysis and decision support tools enable all critical path tasks
  – High team experience
  – Shared project (POP) model
Technology Enabling factor: *Communications Media*

- **Objective**: Rich
- **Meaning**: Shared and personal, visual, multi-disciplinary, showing functional requirements, design choices and predicted behaviors
- **Risk factors**: Slow process to describe models, explain rationale, evaluate choices, make predictions, create alternatives
- **Team-X Methods**:  
  - Mature modeling and analysis tools
  - Personal workstations
  - Shared “iRoom” displays
Technology Enabling factor: Shared Project *Database*

- **Objective:** Integrated
- **Meaning:** Discipline-specific models all access and store *shared* data easily
- **Risk factors:** data reentry, missing *shared* data
- **Team-X Methods:**
  - Develop good shared generic (POP) model ontology
  - Applications have developed uniform semantics for shared data
  - Designated position assures consistency
Assessment of status of ICE Enabling Factors

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<td>High goal congruence:</td>
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ICE Enabling factors: so what?

- **Necessity**: excellent ICE performance requires *all* factors to work well
- **Sufficiency**: No one factor suffices
- Early evidence (Stanford classes) of necessity, sufficiency of these factors (from observations or theoretically-founded simulation)
- Process and team experience are crucial, so understanding factors may help understand how to change Team-X to
  - Make specific improvements
  - Replicate Team-X (in less than 10 years it to create it)
Goals of ICE sessions session: *Project Definition (v)*

Define:

- What each of the teams expects to deliver (*plans, commitments*)
- What they expect from the other team members (*commitments*)
- How can individuals coordinate their respective and collective scopes (*coordination commitments*)
- How team members know how work is progressing (*risks; measurable process performance metrics*)
- How team members know when (pre)construction is completed (*measurable outcomes*)
- What work resources and methods can be used for (pre)construction work (*controllable factors*)
- What resources and work methods will be used for the (pre)construction (*commitments*)
## Deliverable commitment template - example

<table>
<thead>
<tr>
<th>Planned deliverable</th>
<th>Deliverable format</th>
<th>Responsible team, individuals</th>
<th>Receiving team</th>
<th>Due date</th>
<th>Due date met (y/n)?</th>
<th>Expected LOD</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM spec for current step</td>
<td>BIM content template (Excel)</td>
<td>Core team</td>
<td>BIM architect</td>
<td>Mm/dd</td>
<td></td>
<td></td>
<td>Top-10 $ elements</td>
</tr>
<tr>
<td>BIM review</td>
<td>BIM content template (Excel)</td>
<td>Review team x 50</td>
<td>PM</td>
<td>Mm/dd</td>
<td>[1:5] each team</td>
<td></td>
<td>No team priority yet</td>
</tr>
<tr>
<td>Schedule of assets to manage</td>
<td>Excel format</td>
<td>BIM author</td>
<td>FM manager</td>
<td>Mm/dd</td>
<td>all rooms &gt; 10 ft²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Next step plan development</td>
<td></td>
<td>Core team</td>
<td>PM</td>
<td>Mm/dd</td>
<td>Task size 2-5 FTE-weeks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sr Mgt approve next step</td>
<td>email</td>
<td>Sr Management</td>
<td>PM</td>
<td>Mm/dd</td>
<td>Yes/no/ buts</td>
<td></td>
<td>Decision required</td>
</tr>
</tbody>
</table>
## Coordination commitment template

<table>
<thead>
<tr>
<th>Planned coordination activity</th>
<th>Responsible individuals</th>
<th>Due date</th>
<th>Due date met (y/n)?</th>
<th>Expected LOD</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Commitment conformance**

<table>
<thead>
<tr>
<th>Time</th>
</tr>
</thead>
</table>

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## Controllable factors template - example

<table>
<thead>
<tr>
<th>Factor Type</th>
<th>Factor</th>
<th>Range of options: choice impacts BIM specifications</th>
<th>Constraints</th>
<th>Action(s) for this week</th>
<th>Action Taken? (Yes, Partial, No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>Detail of water line in 3D</td>
<td>Features of size from 1 mm to &gt; 1m</td>
<td>None important</td>
<td>Model features size &gt; 20 mm</td>
<td></td>
</tr>
<tr>
<td>Product</td>
<td>Location of in-water equipment</td>
<td>Adjust both equipment location, water width/depth profile</td>
<td>Size of equipment</td>
<td>model equipment located in water this week</td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>Number of BIM authors</td>
<td>&lt;1 – many FTEs</td>
<td>Adjust author count up and down slowly</td>
<td>Budget BIM author work</td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>Number of BIM reviewers</td>
<td>Author team – hundreds</td>
<td>Size of BIM review facility</td>
<td>Budget BIM reviewer work</td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Construction duration</td>
<td>6 months to 2 years</td>
<td>Need to plan prefabrication early to shorten construction period</td>
<td>Get owner preference</td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Size of weekly pre-con tasks</td>
<td>One task for whole team/week to all tasks with &gt; 0.5 FTE-day</td>
<td>Availability of staff to plan, manage schedule</td>
<td>Build short-interval production plan and schedule at feasible LOD</td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Tool used for BIM review</td>
<td>BIM authoring, BIM review, Navisworks</td>
<td>Training of review team to understand content</td>
<td>Provide and train in best available tool supported within company</td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Invitation list next meeting</td>
<td>do not do it to invite core team + all who might help</td>
<td>Need to do it at least 3 days before meeting</td>
<td>Invite estimator, others x 10 by COB today</td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Develop agenda, purpose, intended outcomes of next meeting</td>
<td>Agenda items: 1 + 2-5 subheadings; purpose set by current project status; outcomes none to schedule and commitment clarity of assigned tasks x 5-10</td>
<td>meeting date; attendee availability</td>
<td>create agenda; coordinate with AV; test technology</td>
<td></td>
</tr>
</tbody>
</table>
## Metrics Implementation template - example

<table>
<thead>
<tr>
<th>Name</th>
<th>Comment</th>
<th>Target value</th>
<th>Tolerance: +,-,(\pm)</th>
<th>How to use in management</th>
<th>Source of data</th>
<th>Type [P, O]</th>
<th>Stakeholders who saw data last week</th>
<th>Collection frequency</th>
<th>Prediction</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Quality: POE satisfaction wrt program (%)</td>
<td>100</td>
<td>5</td>
<td>Guide commissioning, next job</td>
<td>Client assessment</td>
<td>O</td>
<td>Owner only</td>
<td>Turnover time + 6-24 months</td>
<td>40</td>
<td>98</td>
</tr>
<tr>
<td>E</td>
<td>Cost conformance to plan (item actual - predicted/predicted)</td>
<td>100</td>
<td>5</td>
<td>Plan next job</td>
<td>Client assessment</td>
<td>O</td>
<td>PM only</td>
<td>Turnover time</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>Schedule conformance to plan (%)</td>
<td>100</td>
<td>10</td>
<td>Plan next job</td>
<td>Client assessment</td>
<td>O</td>
<td>All on team</td>
<td>Turnover time</td>
<td>35</td>
<td>95</td>
</tr>
<tr>
<td>R</td>
<td>Predicted Cost conformance to plan (item actual - predicted/predicted)</td>
<td>100</td>
<td>5</td>
<td>Attention management</td>
<td>Periodic project progress report</td>
<td>P</td>
<td>Subteam only</td>
<td>Weekly</td>
<td>15</td>
<td>99</td>
</tr>
<tr>
<td>I</td>
<td>Production schedule conformance to plan (%)</td>
<td>90</td>
<td>10</td>
<td>Attention management</td>
<td>Periodic project progress report</td>
<td>P</td>
<td>Owner only</td>
<td>Weekly</td>
<td>10</td>
<td>75</td>
</tr>
<tr>
<td>C</td>
<td>Assessed Quality conformance to plan (% of items with rating &gt;=4 on scale 1-5)</td>
<td>100</td>
<td>10</td>
<td>Attention management</td>
<td>Periodic project progress report</td>
<td>P</td>
<td>Subteam only</td>
<td>Weekly</td>
<td>15</td>
<td>95</td>
</tr>
<tr>
<td>S</td>
<td>Stakeholder participation that is timely and meaningful (%)</td>
<td>90</td>
<td>10</td>
<td>Adjust plan by stakeholder review and assessments</td>
<td>Periodic project stakeholder survey</td>
<td>P</td>
<td>All on team</td>
<td>Weekly</td>
<td>10</td>
<td>90</td>
</tr>
</tbody>
</table>

C: Controllable; P: Process; O: Outcome
Comment: Graph shows assessed status of the predicted/measured performance of each metric defined in Metrics template.

Managerial significance of this assessed metrics status graph: Most metrics have very good predicted performance for this design version. Team should focus attention on high risk areas of cost and production schedule conformance.
## Risk template - example

<table>
<thead>
<tr>
<th>Identified risk</th>
<th>Potential impact of risk ($, time, effort)</th>
<th>Severity: Low, Medium, High</th>
<th>Parties affected by risk</th>
<th>Individuals responsible for mitigating design, approval</th>
<th>Earliest analysis/ last responsible moment dates</th>
<th>Mitigation activity</th>
<th>Resolution date met (Yes/No)?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM ready partner teams available</td>
<td>Dramatic schedule</td>
<td>High</td>
<td>Client</td>
<td>Early partner relationship team</td>
<td>Day-1/ end of concept phase</td>
<td>BIM training for partner staff</td>
<td></td>
<td>Best to set expectat-ions early</td>
</tr>
<tr>
<td>Sea level rise</td>
<td>Costs/ curtailed operations</td>
<td>Medium</td>
<td>Operations</td>
<td>Concept design team</td>
<td>Day-1/ end of Concept</td>
<td>Dikes</td>
<td></td>
<td>100-year risk</td>
</tr>
<tr>
<td>Goverment plan OK</td>
<td>Delay open day</td>
<td>Medium</td>
<td>Operations</td>
<td>Core group</td>
<td>Day-1/ facility open</td>
<td>Engage government review early</td>
<td></td>
<td>Ongoing risk</td>
</tr>
<tr>
<td>Paint spec unclear or inappropriate</td>
<td>Cost: use contingency; schedule delay</td>
<td>Low</td>
<td>Client</td>
<td>Core group</td>
<td>Day-1/ facility open</td>
<td>Vet across different examples</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Time

- **Client**
  - Early partner relationship team
  - Day-1/ end of concept phase
  - BIM training for partner staff
- **Operations**
  - Concept design team
  - Day-1/ end of Concept
  - Dikes
- **Core group**
  - Day-1/ facility open
  - Engage government review early
  - Ongoing risk
- **Vet across different examples**
- **Engage government review early**
- **Best to set expectat-ions early**
To read more

- Section *Integrated Concurrent Engineering (ICE)* supports VDC
  - Pp 34-38 in VDC recommended reading
## ORID: Focused Conversation and Analysis

<table>
<thead>
<tr>
<th>Objective</th>
<th>Reflective Positive</th>
<th>Reflective Negative</th>
<th>Interpretive</th>
<th>Decisional</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you recall seeing?</td>
<td>What do you feel positive about?</td>
<td>What do you find negative?</td>
<td>What sense do you make of it?</td>
<td>What agreements can be made now?</td>
</tr>
</tbody>
</table>

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### Overview

<table>
<thead>
<tr>
<th>Session</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Concurrent Engineering (ICE):</td>
<td>Develop, show and explain the product, organization, process, POP and 4D models as well as analyses of each and recommendations for management based on the design exercise – collaboratively and quickly</td>
</tr>
</tbody>
</table>