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Enabling Sustainability in the A/E/C Industry:
A National Perspective on What Works & Why

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Enabling Sustainability in the A/E/C Industry:
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The **Future** arrives every second as today’s reality, and it does not have “Pause” nor “Reset” buttons….  

... and, whether we like it, accept it, or even care about it, **Sustainability** is an integral part of the Future, if not it’s only hope....
So, from an A/E/C Industry point of view, the question is:

... are we going to contribute to make the Future we want happen...?

... are we going to just wait and see what type of Future happens...?

... or are we going to ask, when the Future arrives, what happened...?
The fundamental question when anyone begins to talk about Sustainability in the A/E/C Industry is:

“What do you mean by sustainability...?”
There is no single, easy answer to this question…

- In answering this question, some people will try to make you feel:
  - **Scared**… (the possible outcomes)
  - **Bad**… (the statistics and blame)
  - **Guilty**… (the greater good)
  - **Confused**… (the intellectual base)
  - **Relieved**… (the technological fix)
- But this is not the point…
Sustainability has brought together a diverse set of constituencies...

And many, many, many more...
Some Selected Examples

- World Bank
- World Business Council for Sustainable Development (WBCSD)
- World Federation of Engineering Organizations (WFEO)
- The Business Roundtable (BRT)
- The U.S. Green Building Council (USGBC)
- The U.S. Army Corps of Engineers
- U.S. Federal Government (Departments and Agencies)
- Urban Land Institute (ULI)
- The Construction Industry Institute (CII)
- The National Center for Construction Education and Research (NCCER)
- … and many others
So, let’s see what works and why...
The first thing that works is:

(1) Do not get hung up on a definition, or on the definition of sustainability...

Instead, focus on what it is that we want/need to sustain...
Now, the answer is simple:

But unfortunately, sustainability is not sexy enough... and in reality, quite complex...
The second thing that works is:

(2) Understand the **context of sustainability**…

*This means, understand the **dimensions** and the **scales** of sustainability, and the **influences** that can affect it…*
People
The Built Environment

- Residential Facilities
- Civil Infrastructure Systems
- Non-Residential Facilities
- Industrial Facilities
Production Systems

Goods

Products

Services
The Natural Environment

- Air
- Water
- Soil
- Biota (Plant and Animal Species)
The Resource Base

- **Natural Capital**: (Renewable and Non-renewable Resources)
- **Social Capital**: (Professional and Non-professional Workforce)
- **Industrial Capital**: (Products, Goods, Services)
- **Built Capital**: (Facilities and Infrastructure)
- **Economic Capital**
Scales

The Built Environment

Residential Facilities
Non-Residential Facilities
Civil Infrastructure Systems
Non-Civil Infrastructure Systems

People

Body
Mind
Soul

Hand

Sustainability Pentagon

Air
Water
Soil
Biotas

Products
Services

The Natural Environment

The Resource Base

SITE FOOTPRINT
LOCAL FOOTPRINT
STATE FOOTPRINT
REGIONAL FOOTPRINT
NATIONAL FOOTPRINT
GLOBAL INTERNATIONAL FOOTPRINT

TODAY
1 YEAR
1 – 5 YEARS
5 – 10 YEARS
10 – 25 YEARS
25 – 50 YEARS +
Spatial Scale

- SITE FOOTPRINT
- LOCAL FOOTPRINT
- STATE FOOTPRINT
- REGIONAL FOOTPRINT
- NATIONAL FOOTPRINT
- GLOBAL INTERNATIONAL FOOTPRINT
Temporal Scale

- TODAY
- 1 YEAR
- 1 – 5 YEARS
- 5 – 10 YEARS
- 10 – 25 YEARS
- 25 – 50 YEARS +
Influences

Social, Cultural, Political, and Regulatory Systems

Economic and Financial Systems

Ecological and Environmental Systems

SITE
FOOTPRINT
LOCAL FOOTPRINT
STATE FOOTPRINT
REGIONAL FOOTPRINT
NATIONAL FOOTPRINT
GLOBAL INTERNATIONAL

TODAY
1 YEAR
1 – 5 YEARS
5 – 10 YEARS
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Sustainability
Pentagon

People

Residential Facilities
Non-Residential Facilities
Civil Infrastructure
Industrial Facilities

The Built Environment

Production Systems

Air
Water
Soil
Biota (Plant and Animal Species)

The Natural Environment

The Resource Base

Natural Capital (Renewable and Non-renewable Resources)
Social Capital (Professional and Non-professional Workforce)
Economic Capital (Industrial Capital, Products, Goods, Services, Economic Capital, Industrial Capital)
Built Capital (Facilities and Infrastructure)

Body
Mind
Heart
Soul

Individuals
Families
Organizations
Communities
The third thing that works is:

(3) Acknowledge that sustainability inevitably will lead to change in the A/E/C industry, in A/E/C enterprises, and in A/E/C projects...

This means, understand the triggers, the drivers, and the implications of change...
### Triggers of Change

**ATTITUDE TOWARD CHANGE**

<table>
<thead>
<tr>
<th>Proactive</th>
<th>Reactive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FLASH</strong></td>
<td><strong>CRASH</strong></td>
</tr>
<tr>
<td>Triggers are changes in:</td>
<td>Triggers are changes of:</td>
</tr>
<tr>
<td>• Values</td>
<td>• Functional Requirements</td>
</tr>
<tr>
<td>• Mission</td>
<td>• Physical Integrity / Function</td>
</tr>
<tr>
<td>• Perceptions</td>
<td></td>
</tr>
<tr>
<td><strong>SPLASH</strong></td>
<td><strong>CLASH</strong></td>
</tr>
<tr>
<td>Triggers are changes caused by:</td>
<td>Triggers are changes in:</td>
</tr>
<tr>
<td>• Market</td>
<td>• Codes</td>
</tr>
<tr>
<td>• Benchmarks</td>
<td>• Regulations</td>
</tr>
<tr>
<td>• Competition</td>
<td>• Standards</td>
</tr>
</tbody>
</table>

Regardless of the trigger, sustainability will inevitably force change, and how organizations respond will make them end... either with a Pile of CASH... or as a Pile of ASH...
Drivers of Change: The Global Market

- Residential (34%)
  - Single-family homes
  - Townhouses
  - Apartments
  - Condos

- Heavy Engineering (17%)
  - Dams
  - Highways
  - Airports
  - Pipelines

- Industrial (16%)
  - Refineries
  - Power Plants
  - Steel Mills
  - Heavy Mfg.

- Building Construction (33%)
  - Schools
  - Office Buildings
  - Warehouses
  - Shopping Centers
Drivers of Change: The Global Market

- Single-family homes
- Townhouses
- Apartments
- Condos

- Heavy Engineering (17%)
  - Dams
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  - Pipelines

- Building Construction (33%)
  - Refineries
  - Power Plants
  - Steel Mills
  - Heavy Mfg.

- Residential

$3.4 Trillion Dollars/year

- Schools
- Office Buildings
- Warehouses
- Shopping Centers
Drivers of Change: Clients

TO MAKE MONEY...!

Communicate Specifications

A/E/C ENTERPRISE

Establish Needs

SUPPLIERS

Resources

Products
Services

CLIENTS

Quality of Execution (Definition & Delivery)

Quality of Conformance
Drivers of Change: Clients

CLIENTS ARE EXPECTING/REQUIRING BETTER LONG TERM SOLUTIONS, NOT JUST PRODUCTS AND SERVICES...

- Quality of Performance
- Quality of Redesign/Improvement
Implications of Change

- **Strategic**
  - Sustainability requires change toward a system-based approach to A/E/C projects

- **Tactical**
  - Sustainability requires change in the attributes and characteristics of the solutions offered to clients…
  - in the delivery and use of these solutions…
  - in the resources required in the delivery and use of these solutions…

- **Operational**
  - Sustainability requires change in the processes, practices, and standard operating procedures followed in the delivery and use of these solutions particularly the decisions and choices made, and the actions taken,

- Sustainability requires change in Mental Paradigms
Implications of Change: Strategic

A/E/C Project as a System

Internal Context

External Context

System Equilibrium with External Context

Internal Context

External Context

Contextual System Response:
- Sustainability
- Flexibility
- Adaptability
- Scalability
- Robustness

A/E/C Project Subsystems

SUBSYSTEM (A)

SUBSYSTEM (B)

SUBSYSTEM (C)

SUBSYSTEM (...X)

Subsystem Relationships and Behaviors

(A)

(B)

(C)

Intrasubsystem Behavior

Intersubsystem Behavior

Extra-subsystem Behavior
Integration and Application of Sustainability:
- Principles
- Concepts
- Heuristics
- Strategies
- Guidelines
- Specifications
- Standards
- Tools
- Best Practices
- Lessons Learned

Processes for the Delivery and Use of a Specific A/E/C Project

Definition of the Contextual Envelope of a Specific A/E/C Project

Compatibility

Characteristics and Requirements of a Specific A/E/C Project

Resources for the Delivery and Use of a Specific A/E/C Project

Implications of Change: Tactical
Implications of Change: Tactical

Integration and Application of Sustainability:
- Principles
- Concepts
- Heuristics
- Strategies
- Guidelines
- Specifications
- Standards
- Tools
- Best Practices
- Lessons Learned

Enhanced Characteristics

Enhanced Processes

Enhanced Contextual Envelope

Enhanced Resource Use

Enhanced Compatibility
Implications of Change: Operational


Operations & Maintenance Processes

Procurement Process

Planning Process

Design Process

Construction Process

Commissioning Process
Implications of Change: Operational


- Planning Process
- Design Process
- Construction Process
- Commissioning Process
- Procurement Process
- Operations & Maintenance Processes
Implications of Change: Operational


Procurement Process
Procurement
Contract Selection
Practices & SOP’s
End-of-Service-Life Transition
Practices & SOP’s

Planning Process
Planning
Processes & SOP’s

Design Process
Design
Practices & SOP’s

Construction Process
Construction
Practices & SOP’s

Commissioning Process
Commissioning
Practices & SOP’s

Operations & Maintenance Processes
Operations & Maintenance
Practices & SOP’s
Implications of Change: Operational


- Project Characterization Practices & SOP’s
- Team Definition & Building Practices & SOP’s
- Contract Selection Practices & SOP’s
- Procurement Practices & SOP’s
- End-of-Service-Life Transition Practices & SOP’s
- Project Definition Practices & SOP’s
- Procurement Process
- Planning Process
- Design Process
- Construction Process
- Commissioning Process
- Operations & Maintenance Processes
- Planning Practices & SOP’s
- Design Practices & SOP’s
- Construction Practices & SOP’s
- Commissioning Practices & SOP’s
- Operations & Maintenance Practices & SOP’s

Implications of Change: Operational
Implications of Change: Mental Paradigms

- There is no Unified Theory of Sustainability; it can be expressed in multiple forms:
  - ...Principles
  - ...Concepts
  - ...Heuristics
  - ...Strategies
  - ...Guidelines
  - ...Specifications
  - ...Standards
  - ...Tools
  - ...Best Practices
  - ...Lessons Learned

So, which of these forms of Sustainability must/should/could we use?

The answer is ANY...
Implications of Change: Mental Paradigms

We need to go beyond just discussing the **Theoretical Dimensions** of sustainability...

and start focusing on the **Practical Implementation** of sustainability...
Implications of Change: Mental Paradigms

We need to stop listening to those that only know how to say **Why Not!**…

and start listening to those that only know how to say **Why Not?**…
We need to overthrow the Tyranny of the OR...

and embrace the Genius of the AND...

It is not GREEN ($) or GREEN, it is GREEN ($$$) and GREEN
The fourth thing that works is:

(4) Overcome the inhibitors of sustainability, and embrace the enablers of sustainability...

This means, accept that there are multiple paths to sustainability...
The Multiple Paths Toward Sustainability

- Sustainable System Approach to Industry…
- A/E/C Industry Collaboration…
- Streamlined A/E/C Enterprises…
- Expanded A/E/C Project Scope…
- Integrated A/E/C Project Life Cycle…
- Integrated and Aligned Project Team…
- Expanded Project Performance Paradigm …
- Minimum Waste Levels…
- Learning Organization Environment…
From an unsustainable linear approach to development…
…to a Sustainable Systems Approach

Social/Cultural, Ecological/Environmental, Economic, and Technological, Context

Production and Use of Energy

Extraction and Use of Primary Resources

Renewable and Nonrenewable Natural Resources

Processing and Manufacture

Technologies, Systems, Products, and Materials

Transportation and Commercialization

Use and Consumption of Technologies, Systems, Products, Materials, and Services

Delivery, Operation and Maintenance of Civil Infrastructure Systems

Resource Recovery

Reduction/ Elimination of Resource Depletion and Degradation

Reduction/ Elimination of Waste Generation and Accumulation

Reduction/ Elimination of Environmental Impact and Degradation

End-of-Service-Life Decision

Intra- and Intergenerational Satisfaction of Human Needs and Aspirations

GRADUAL CHANGE TOWARDS SUSTAINABILITY
From A/E/C Industry fragmentation…
### Total Life Cycle Delivery of Technologies, Systems, Products, Materials, & Equipment

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>Design</td>
</tr>
<tr>
<td>Procurement &amp; Construction</td>
<td>Commissioning &amp; Start-up</td>
</tr>
<tr>
<td>Operations &amp; Maintenance</td>
<td>End-of-Service Life</td>
</tr>
<tr>
<td>End-of-Service Life</td>
<td></td>
</tr>
<tr>
<td>Total Life Cycle Delivery of Facilities</td>
<td></td>
</tr>
<tr>
<td>Delivery of Facilities</td>
<td>Collaboration</td>
</tr>
<tr>
<td>Delivery of Civil Infrastructure Systems</td>
<td>Pull/Push</td>
</tr>
<tr>
<td>Delivery of Technologies, Systems, Products, Materials, &amp; Equipment</td>
<td>Pull/Push</td>
</tr>
</tbody>
</table>

…to A/E/C Industry Collaboration
From conventional A/E/C Enterprises…
... to Streamlined A/E/C Enterprises

Developing External Strategic Alliances and Partnerships

IMPORTANT INFRASTRUCTURES AND COMPETENCIES (External)

Infrasctructures:
- Physical
- Human
- Technological
- Technical
- Management
- Administrative

Core Assets and Competencies:
- Information/Data
- Knowledge/Experience
- Abilities/Skills
- Technological Proficiency

ENTERPRISE
(Effective, Efficient, Productive & Profitable)

ESSENTIAL INFRASTRUCTURES, ASSETS, & CORE COMPETENCIES (Internal)

NON-ESSENTIAL AND UNIMPORTANT INFRASTRUCTURES, ASSETS, & COMPETENCIES

Educating and Training Personnel

Streamlining and Right-sizing

GLOBAL ECONOMY, MARKETS & CLIENTS
From a limited and narrow view of A/E/C Project Scope…
...to an Expanded A/E/C Project Scope

PROJECT DEFINITION PACKAGE
- Performance Parameters (Short- and Long-Term Performance)
- Influences on the Project (Characteristics, Objectives, Scope, Physical Context, Non-Physical Context, and Risks)
- Perspectives (Owner, User/Operator, Designer, Constructor, Vendors/Suppliers, External Parties)

GENESIS
- Problem
- Need
- Opportunity

PROJECT ORIGINATOR
- Enterprise
- Organizational Unit
- Functional Unit
- Individual

PRODUCT/ SERVICE
- Solution
- Satisfaction
- Realization

RESOURCES
- Economic and Financial Resources
- Physical Resources (Materials, Equipment, and Tools)
- Human Resources (Technical, Non-Technical, and Administrative Personnel)
- Intellectual Resources (Data/Information, Knowledge/Experience, Abilities/Skills, Technological Proficiency)
- Technological Resources (Computing, Communication, Collaboration, and Management of Información Tecnologías)

PROJECT DELIVERY
- (Effective and Efficient Planning and Execution)

Duration
Start
End

Feedback
From a very fragmented execution of an A/E/C Project through its life cycle...

**Procurement Phase**
Vendors/Suppliers Team
(Materials/Equipment)

**Planning Phase**
Owner Team
(May Include Users/Operators)

**Design Phase**
Design Team
(Engineers/Architects)

**Construction Phase**
Construction Team
(Construction Managers/General Contractors/Subcontractors)

**Operation Phase**
Operations Team
(Users/Operators)
Bid Or Negotiate, & Award
Design Team (Engrs./Archs.)

Construction Team (Cms./Gcs./Scs)

Owner Team (May Include Users/Operators)

Operations Team

Preliminary Planning & Funding
Project Definition Package

Conceptual/Schematic Design

Design Development

Contract Documents

Procurement

Assessment & Objectives Setting

Preliminary Planning & Funding

Bid Or Negotiate, & Award

Construction Planning

Execution

Start-Up

Operational/ Maintenance/ Management

End of Service Life Decision

Decommission

Deconstruct

Rehabilitate

Retrofit

Recover

Restore

Remediate

Problems Needs Opportunities

External Parties

Potential Active Participation

Planning Phase

Design Phase

Construction Phase

Operation Phase

Integrated A/E/C Project Life Cycle
From multiple stakeholders who are not aligned…
Acceptable Tolerances and Team Norms

Set of Common and Well-Defined Project Goals and Objectives

Strong Leadership

Partnering and Team Maintenance Processes

Financial Institutions
- Insurance Companies
- Bonding Companies
- Regulatory Agencies
- The Community
- The General Public
- Other

Project Goals and Objectives

Key Links in the Total Supply Chain

Partnering Development and Team Building Processes

Acceptable Tolerances and Team Norms

External Parties

Owner Team

User/Operator Team

Design Team

Construction Team

Team of Vendors/Suppliers

Internal & External Organizations

Individuals

Functional Units

Internal & External Organizations

…to an Integrated and Aligned Project Team
From an entrenched paradigm of project performance…
… to an expanded paradigm of Project Performance
From high levels of waste...

- “Waste” any human activity which absorbs resources but creates no value
- Mistakes which require rectification
- Production of items that are not wanted (inventories and stockpiles)
- Processing steps that are not needed
- Movement of people or transport of goods from one place to another without any purpose
- People waiting in a “downstream activity” because an “upstream activity” has not delivered
- Products and services that do not meet the needs of the customer
…to Minimum Waste Levels

- Increased labor productivity
- Reduced production throughput times
- Reduced inventories in the system
- Reduced time-to-market of new products
- Reduced errors reaching the customers
- Reduced scrap in the production process
- Reduced job-related injuries
- Wider variety of products at a very modest additional cost
- And all of this, with modest capital investments…
From no institutional memory within our enterprises...

Planning Process
- Planners
- Engineers/Architects
- Special Consultants

Preliminary Studies
(At Different Levels of Definition)
- Constructability, Procurability, Commissioning, Operability, Maintainability, Health, Sustainability Analyses during Planning and Design

Design Process
- Architects
- Engineers
- Specialty Designers

Plans and Specifications
(At Different Levels of Definition)

Construction Process
- Construction Managers
- Contractors
- Subcontractors
- Vendors

Evaluation Of Project Construction Performance
- Cost & Schedule
- Quality & Safety
- Productivity
- Constructability & Procurability

Constructed Facility
(At System, Subsystem or Component Levels)

Operations & Maintenance Processes
- Plant/Facility Managers
- Operators/Users
- Maintenance Personnel

Evaluation Of Facility Operations Performance
- Production
- Ownership, Operation, and Maintenance Costs
- Operability, Maintainability, Health & Sustainability

Institutional Memory Sink

Analysis of Actual Performance
…to a Learning Organization environment
Is all this hard to imagine...?

Impossible to achieve...?

Not really, but it will require some level of change in:

In our *Decisions*...

In our *Choices*...

In our *Actions*...

In our *Paradigms*...
The fifth thing that works is:

(5) *Just do it*...

This means, start **educating and training** all stakeholders, start using **existing tools**, start sharing **best practices**, **lessons learned**, and **case studies**...
This last point can be the focus of many more hours of discussion...
So, let me leave you with these thoughts...
Reflections

- Timely opportunity for the A/E/C industry to take a proactive lead in implementing Sustainability
- Anchor implementation efforts in an understanding of the context, the inhibitors, and the enablers in both education and research
- Remember, Sustainability can be implemented:
  - one decision at a time
  - one choice at a time
  - one action at a time
  - one paradigm at a time
  - one product or process at a time
  - phase by phase in a product’s or a project’s life cycle
  - one project at a time
  - one enterprise at a time
  - in a gradual shift to a sustainable future……
Let me conclude with a short story of an impressive naval fleet that encounters a small light approaching them directly in a dark, stormy night...
The Exchange...

- “I am Admiral Jones from the U.S. Navy. Identify yourself, and move 5 degrees south.”
- “I am Bob Smith, and no, I won’t move… I suggest you move 5 degrees north.”
- “You do not understand Son, I am Admiral Jones from the U.S. Navy, and I have enough ships and firepower to blow you out of the water. I suggest you move immediately 5 degrees south…”
- “You do not understand Sir. I am not moving anywhere. I suggest you move 5 degrees north….”
“You see Sir, I am just the lighthouse operator…”

“Your call…”
So, to anyone in the A/E/C Industry who believes that they will avoid having anything to do with sustainability...

...all I can say is...

...your call...
Thank you...
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Any Questions…?