Harmonized Sustainability—
Challenging the Status Quo

by
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Abstract

This article attempts to objectively define and discuss sustainability overlap that concurrently exists between four core principles described herein. The four pillars (silos) in the order presented are: Total Worker Health (TWH); Occupational Health and Safety Management Systems (OHSMS); Green Building (LEED); and Product Stewardship (Green Chemistry). The three conceptual models presented are: Concentric; Hierarchal, and Cyclic. These models are offered to help visualize the inter-relationships that can produce healthy, safe, secure, and sustainable construction sites. The principles and concepts introduced represent examples of a *continuous-improvement* mindset towards safe and healthy work conditions, a clean, protected environment; improved quality of life; as well as tools, equipment, processes, materials and building designs that prevent (eliminate) hazards and risks before they ever get to become injuries and illnesses. Several 'Prevention through Design' (PtD) examples are described. By incorporating these sustainability concepts into every construction project big and small; safe, healthy, secure, productive and profitable outcomes are inevitable.

Our Earth, a relatively small planet, has formed (evolved) over 4+ billion years and currently supports carbon-based life. Our fragile atmosphere and topography appears to be degrading from rapid (climate) change, growing human population and our expedited quest to consume all the non-renewable (finite), natural resources (e.g., fresh water, fossil fuel, clean air, etc.). Going forward, our quality of life and even survival depends upon our collective ability to find holistic and permanent solutions to these inevitable challenges.

Sustainability covers a wide range of subject areas, definitions and interpretations depending on the context within which it is being viewed. One germane definition may read something like: "to adopt and embrace policies, strategies and technologies that meet societies' present needs without sacrificing the ability of future generations to meet their own." [1, 2] Sustainability can be divided into four pillars or silos: Total Worker Health (TWH); Occupational Health/Safety Management Systems (OHSMS); Green Build (LEED); and Product Stewardship. Figures 1 through 3 offer three interpretations: Concentric, Hierarchal, and Cyclic.

Total Worker Health™ (TWH)

TWH™ is a program and strategy launched in June 2011 by the National Institute of Occupational Safety and Health-NIOSH [3] to integrate occupational safety and health protection with health promotion (disease prevention) in order to enhance overall worker well being and to pre-empt injury and illness on and (hopefully) off the job. Table 1 highlights the overall program goals. NIOSH chose to trademark the phrase, thus helping to create and establish a specific and enduring meaning.

The TWH™ Program brings together fragmented, disconnected and disenfranchised organizational departments, jurisdictions and activities into a singular shared focus: *protecting and promoting the total health, safety and well being of workers*. The Program is divided into three 'Perspectives': Workplace; Employment; and Workers outlined in Table 2. Table 3 lists several program integration examples.

Table 1

NIOSH TWH™ Program Goals
• Examine a broad scope of workplace, employment, and workforce factors to offer to the nation policies, programs and practices to better protect and promote worker health. • Promote the adoption of proven policies and practices to protect and improve worker health both on and off the job. • Motivate trans-disciplinary collaboration among investigators focused on improving and protecting worker health. • Reduce professional barriers and encourage synergistic (multi-disciplinary) interventions. • Encourage and support rigorous evaluation of comprehensive and integrative approaches.

Table 2

WORKPLACE *Protecting Worker Health and Safety*	**EMPLOYMENT** *Preserving Human Resources*	**WORKERS** *Promoting Health/ Well Being*
1. Control of Hazards and Exposures 2. Injury, Illness and Fatality Prevention 3. Promoting Healthy and Safe Work 4. Risk Assessment and Control	5. New Employment Patterns 6. Health and Productivity 7. Healthcare and Benefits	8. Optimal Well Being 9. Workers with Higher Health Risks 10. Compensation and Disability
Adapted from 'Issues relevant to Total Worker Health™ graphic illustration, updated August 2013 [3].		

Table 3

TWH™ Integration Examples
• Respiratory protection programs that address curtailing tobacco use and smoking cessation. • Stress management to reduce stress and build resiliency. • Ergonomic interventions that address joint health and arthritis management strategies. • Comprehensive screenings for work-related and non work-related health risks. • Regular joint meetings of safety team and health promotion teams. Note: Integration of health and safety protection, health promotion and disease prevention create improvements in the working conditions (and the environment) that benefit all stakeholders.

TWH™ is at the heart of *Harmonized Sustainability*. That is, valuing, protecting and preserving human (environmental) resources from design to de-construction. Its significance is depicted in Figures 1, 2 and 3. Introducing TWH™ into day-to-day operations can be challenging to say the least. Irrespective of the business location, TWH™ must begin with top management awareness, recognition, acceptance, support and commitment (i.e., funding, equipment, materials, and labor) to carry out the consistent, on-going implementation at all organizational levels.

Figure 1 — Concentric

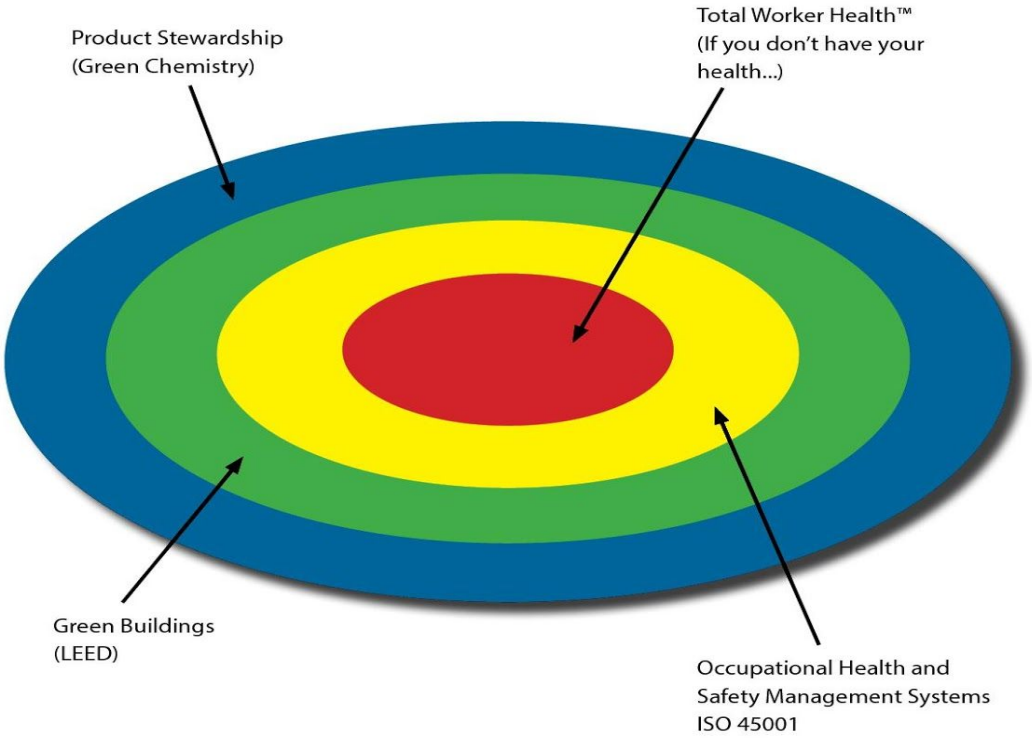
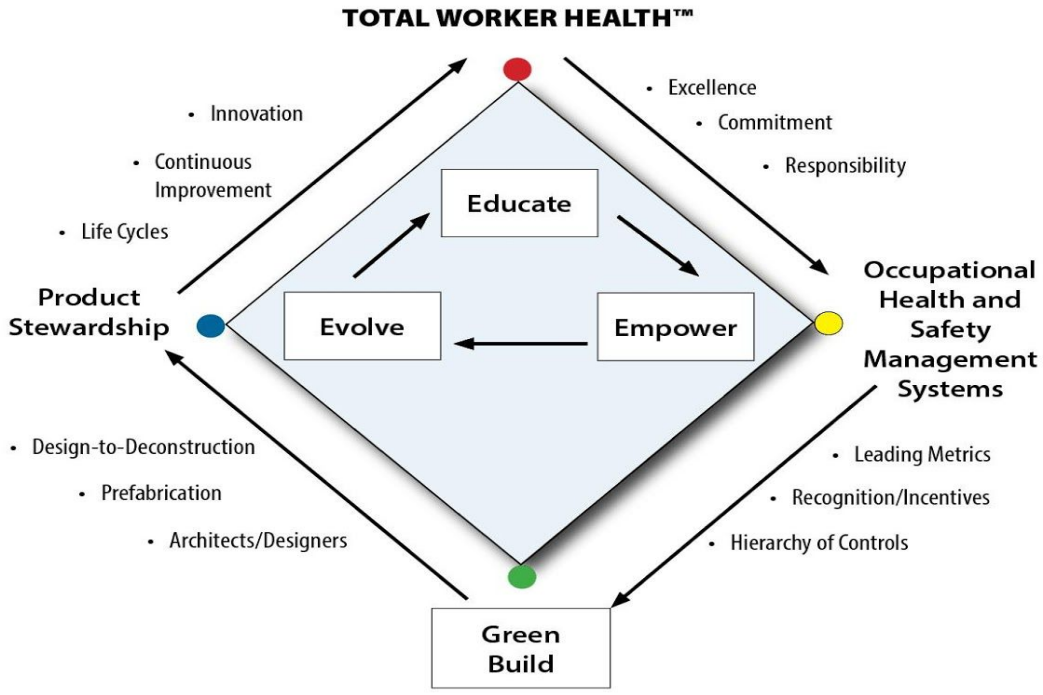


Figure 2 — Hierarchal

Figure 3 — **Cyclic**



Occupational Health and Safety Management Systems (OHSMS)

Implementation of these systems can support sustainability initiatives ensuring workers are safer, healthier with increased profitability. The globally-diverse and country-specific management systems currently in use have been somewhat unified (codified) through the joint efforts of the International Organization of Standardization-ISO [4] members whose voluntary standards have been widely accepted and adopted. Examples of ISO management systems include 9001 (Quality), 14001 (Environment), 18001 (Occupational Health and Safety). These consensus standards outline specifications for the development and assimilation of measurable organizational policies, practices and procedures. *ISO 45001* [5] has been designed to be consistent with other international standards and encourage the integration of its

requirements into the organization's overall management process. Its primary intent is to prevent injury and ill-health to workers within the construct of a safe, secure and sustainable workplace.

Excellence

It has been exhaustively shown that organizations which value, embrace and pursue principles of excellence out-perform and out-last their competitors [6, 7]. These pursuits have sustained their competitive business performance over the years largely because employees are highly valued and motivated to innovate, participate, and create new products, goods, and services that customers want to buy.

Continuous Improvement

One key element of workplace excellence is a philosophy of continuous improvement. This is also referred to in the ANSI/ASSE Z10-2012 standard as the "OHSMS Cycle: Plan-Do-Check-Act" [**8**]. A goal of zero injuries, illnesses, and incidents for everyone on a multi-employer construction project (permanent, temporary, contractor, vendor, supplier, and visitor) is an on-going 'work in progress'. It is upper management's responsibility to set the *tone* by establishing, communicating, recognizing, and rewarding excellent (OHS) job performance starting with the front line (where hammer meets nail so to speak). Continuous improvement means that the organizational culture views and values all health and safety incidents as (*near-hit*) learning experiences (*no-blame* game). The investigation process must objectively identify root causes, eliminate them or provide other effective control measures. This requires focus and committed leadership from the CEO on down.

Leadership

Successful leaders focus on continuous improvement. They engage, inspire, influence, motivate and challenge their 'followers' to think in new ways and seek out long term solutions. Leadership behavior is consistent and predictable. They understand the importance of 'walking the talk' and 'actions speaking louder than words'. They are receptive to new experiences, ideas and seek out accurate, objective information before deciding. Their decisions most often serve the needs of the greater good. True leaders create a safety climate that values individual contributions from team players above all else. The Center for Construction Research and Training has put forth eight (8) worksheets [9] to strengthen *safety climates* using leading indicators. The safety climate categories are: Uninformed, Reactive, Compliant, Proactive, and Exemplary. The eight separate worksheet topics are shown in Table 4. The *Exemplary* ideas have been listed for Worksheet #1.

Table 4

Worksheet Topics
1. Demonstrating Management Commitment (e.g. ***Exemplary*** Safety Climate) **Idea #1**—Develop safety policies, procedures and guidelines to ensure they are aligned with other organizational priorities. **Idea #2**—Management should be visible to workers and reflect good safety practices. **Idea #3**—Allocate adequate resources to effectively implement safety activities. **Idea #4**—Management should actively participate in all meetings at all levels. **Idea #5**—Management should strive for Zero hazard as well as zero injury worksites. **Idea #6**—Establish formalized process for corrective action. 2. Aligning and Integrating Safety as a Value. 3. Ensuring Accountability at ALL Levels. 4. Improving Supervisory Leadership. 5. Empowering and Involving Workers. 6. Improving Communication. 7. Training at All Levels. 8. Encouraging Owner/Client Involvement.
Adapted from CPWR-sponsored Safety Culture/Climate in Construction Workshop held June 2013. Read the full workshop report: *http://www.cpwr.com/whats-new/safety-culture-and-climate-construction-bridging-gap-between-research-and-practice*. [9]

I2P2

An Injury and Illness Prevention Program (I2P2) is a management system that proactively analyzes and identifies occupational health and safety hazards and applies a hierarchy of controls to eliminate or minimize worker exposure risk. In California, CAL/OSHA passed a one-of-a-kind regulation [10]. The gist of this performance-based regulation requires management and employee commitment; mandatory safety communication channels; job hazard analysis, investigation, corrective actions and record keeping. The complete list of the IIPP program elements are found in Table 5.

Table 5

IIPP Elements

General

1. Provide safe/healthy working conditions that are free from known dangers.
2. Keep work areas in a clean and sanitary condition.
3. Select/provide required personal protective equipment (PPE) at no cost to workers.
4. Train workers about job hazards in a manner they can understand.
5. Allow workers to report unsafe conditions (hazards) without fear of reprisal.

California

1. Establish a written program to identify specific work site hazards, their controls, and assigned job responsibilities.
2. Adopt and post the "Code of Safe Work Practices".
3. Establish two-way communication to address safety/health issues (e.g., committee, stand-downs).
4. Conduct routine workplace inspections and job hazard evaluations.
5. Incident investigation process to include near hit reporting.
6. Document and review corrective actions with supervisors and employees.
7. Provide training on specific job hazards.
8. Hold safety tailgate meetings a minimum of every 10 days.
9. Maintain records for all compliance and corrective action activities.
10. Review program effectiveness periodically and revise (retrain) as necessary.

Adapted from: *The Construction Safety Guide, Injury and Illness Prevention through Design*; Pages 7-27; Wordrunner Press 2013, ISBN 978-1931002-09-7.

Job Hazard Analyses

(JHA's) are used to help anticipate and recognize chemical, physical, biological, environmental and regional hazards associated with each specific job task and to develop effective control strategies [11]. JHA's should be the centerpiece of injury and illness prevention goals. To be effective, JHA's must be completed before each job begins and in concert with the daily work planning process. The hierarchy of hazard control strategies is: substitution, elimination, engineering, administrative (procedures, safe practices, work zones), and personal protective equipment (PPE).

Prevention through Design (a.k.a. Design for Safety)

It is more efficient to design health and safety into a process than to manage them within a process that is inherently unhealthy and not safe. One of the best ways to prevent injuries, illnesses and fatalities is to identify, avoid, and/or eliminate hazards and effectively manage the on-going residual ("acceptable") risks by anticipating (pre-empting) future health and safety issues throughout the project's life cycle. Another PtD goal is to minimize any downstream costs for future mitigation or control of hazards

that were not initially addressed during the constructability phase. The PtD strategy focuses on avoidance, elimination, substitution, source reduction and the hierarchy of controls to manage risks from design to demolition of work premises, processes, tools, equipment, machinery, and substances. Design and redesign (retrofit) includes construction, manufacture, use, maintenance, reuse, recycling, and disposal. PtD provides a venue for resolving (eliminating) anticipated and recognized hazards during the early planning stages. This 'systems approach' encourages collaboration between owners, architects, contractors, and occupants to design and build each project in a safe, efficient and cost-effective manner [12, 13, 14, 15, 16, 17, 18].

PtD Examples

Falls from heights remains a significant risk for construction workers. *Designing out* fall hazards from roofs may include items such as parapets, ground-level prefabrication, skylight screens (or non-fragile glass), choosing the HVAC equipment location to insure adequate roof edge set-backs, access and clearances for proper installation and future servicing. Controlling fall hazards through pre-design review may include engineered anchorage points for attaching personal fall arrest systems [19, 20].

Ergonomics draws on several scientific disciplines such as physiology, biomechanics, anthropometry, epidemiology and statistics. 3-D Computer-generated tools are evolving that allow the designer (architect) to vary human parameters in order to assess the potential impact each combination has on the risk of (muscular-skeletal) injury for a given task. *Lean* redesign with ergonomic considerations must focus on the end user's needs and optimizing the human-machine interface. Proactive ergonomics in the design phase of lean manufacturing is an opportunity to improve life-cycle performance, promote a healthy workplace, minimize cumulative trauma disorders and increase job satisfaction [21].

Green/Lean Building

Owners (i.e., project decision makers) and architects have the greatest impact on eliminating future downstream safety and health hazards. The U.S Green Building Council (USGBC), founder of the Leadership in Energy and Environmental Design (LEED) rating system, [22, 23] administers a green building certification program that recognizes best-in-class strategies and practices. The four certification levels each require meeting certain point totals (credits): *Certified*, 40-49 points; *Silver*, 50-59 points; *Gold*, 60-79 points; *Platinum*, 80+ points. The tabulated points and credits are aligned with a specific LEED rating system: Building Design/Construction, Interior Design/Construction, Building Operations and Maintenance, Neighborhood Development, and Homes. Once the Owner chooses the appropriate rating system and certification level, they can then use appropriate checklists to guide their design and operational decisions to qualify for that certification level. Table 6 provides a New Construction (Major Renovation) Project Checklist Summary. 'Sustainable Sites' is described in more detail.

Table 6

New Construction Project Checklist Summary
• Location and Transportation — 16 points • Sustainable Sites — 10 points 1. Construction activity pollution prevention — Required 2. Site Assessment — 1 pt. 3. Site development will protect and restore habitat — 2 pts. 4. Open space — 1 pt. 5. Rainwater management — 3 pts. 6. Heat Island reduction — 2 pts. 7. Light pollution reduction — 1 pt. • Water Efficiency — 11 points • Energy and Atmosphere — 33 points • Materials and Resources — 13 points • Indoor Environmental Quality — 16 points • Innovation — 6 points • Regional Priority — 4 points (110 points possible)
Adapted from USGBC, LEED v4 for BD&C: New Construction and Major Renovation Project Checklist.

The bottom line is that green and lean building is oriented toward energy-efficient 'life-cycle' thinking (i.e., design, construction, O&M, renovation, deconstruction). Building-related safety and health must be a shared objective for both upstream designers and downstream users. Research has shown [24, 25] that 42% of 224 construction fatalities (US 1990-2003) included some causal link to design issues. Design matters!

Green Building meets PtD

Green construction specifications using PtD conjures up other concerns about additional costs and future liabilities. In February, 2015 in partnership with NIOSH, the USGBC posted a new pilot credit program entitled: "Prevention through Design" [26, 29] (http:www.usgbc.org/credits/preventionthroughdesignv4). The reasons cited for the adoption of the pilot credit:

1. Reduce injuries and illnesses.
2. Support high performance, cost-effective OSH outcomes.
3. Design structures that reduce or eliminate potential hazards across the building life cycle.

The LEED pilot credit addresses two building life cycle phases: Operations and Maintenance (O&M) and Construction. Table 7 shows the categories on the PtD Pilot Credit Worksheet (Baseline, Discovery, and Implementation).

Table 7

Prevention through Design for Life Cycle Safety and Health Worksheet, Construction; 2/18/2015	
BASELINE describes the assumptions and construction plan for each relevant topic prior to the safety constructability review.	
Site Conditions	
Building Reuse	
Construction Activity Pollution Prevention	
Construction Indoor Air Quality Management	*Example:* Construction plan includes the installation of natural and synthetic stone surfaces on floors 1-5.
Waste Recycling Management	
Materials and Resources	
Work at heights	
Special features	

Table 7 *(continued)*

Prevention through Design for Life Cycle Safety and Health Worksheet, Construction; 2/18/2015	
DISCOVERY describes the key tasks and potential mitigation strategies identified during the safety constructability review that could be used to eliminate or reduce hazards/exposures for the topic area.	
Site Conditions	
Building Reuse	
Construction Activity Pollution Prevention	
Construction Indoor Air Quality Management	*Example:* Reduce hazardous dust exposures Task: Cutting stone materials. Hazard: Silica dust. Exposure: Inhalation during power saw use. Strategy #1- Order pre-cut stone to minimize cutting. Strategy #2- Change to non-stone materials Strategy #3- Use local exhaust ventilated tools to control dust at source.
Waste Recycling Management	
Materials and Resources	
Work at heights	
Special features	

Table 7 *(continued)*

Prevention through Design for Life Cycle Safety and Health Worksheet, Construction; 2/18/2015		
IMPLEMENTATION describes how the safety constructability review resulted in at least one protective measure change made to any of the relevant plans (e.g., building and temporary structure design, Construction (Health and Safety) Plan, Construction Activity Pollution Prevention Plan, Construction Indoor Air Quality Management Plan, or Construction and Demolition Waste Plan.		
Construction Topic	**Protective Measure Change**	**Implementation: Responsible Parties**
Site Conditions.		
Building Reuse		
Construction Activity Pollution Prevention		
Construction Indoor Air Quality Management	*Example:* Construction Safety Plan and Construction Indoor Air Quality Management Plan changed to require contractor use of local exhaust ventilation tools for all natural and synthetic stone cutting on floors 1-5.	
Waste Recycling Management		
Materials and Resources		
Work at heights		
Special features		

The USGBC PtD pilot credit program is predicated on sound research and practice demonstrating that upstream design and planning decisions can influence and improve health, safety and well being for construction workers and end users throughout the life cycle of the building or structure.

Product Stewardship

Definition

To responsibly manage the health, safety and environmental aspects of raw materials, intermediate, and consumer products throughout their life cycle and across the value chain in order to prevent or minimize negative impacts and maximize value [27].

Elements

PS has global implications and it combines many technical disciplines to help ensure products can be used safely and in compliance with the national and local regulations that apply to markets where the products are used. Table 8 lists the various and diverse PS activities.

Table 8

Product Stewardship Activities		
Global Chemical and Product Safety Regulations	Safety Data Sheets, Labels and Safe Handling Instructions.	Dangerous Goods Transportation
Banned/Restricted Substances Management	Sustainable Product/Design Development	Product Safety Testing
Product Exposure and Risk Assessment	Recycling & Take-back Programs	Marketing Claims and Declarations
Customer Inquiries	Adverse Event and Recording Response	
Adapted from: *Core Competencies for the Product Stewardship Professional*; Product Stewardship Society, 2014; www.ProductStewards.org.		

Core Competencies

PS core competencies have been developed to:

1. Serve as a foundation on which to build global knowledge of the profession.
2. Assist potential employers and employees in identifying opportunities to advance the profession.
3. Define the role of PS in advancing environmental, health and safety protections and facilitating commercial supply chains.

The core competencies' areas are: Technical, Regulatory, and Professional and are shown in Table 9.

Table 9

Core Competencies Overview		
Technical	**Regulatory**	**Professional**
1. Basic Science. 2. Manufacturing and Engineering. 3. Toxicology. 4. Environmental Chemistry & Eco-toxicology. 5. Safety Data Sheet (SDS) and Label Authoring. 6. Exposure Assessment and Control. 7. Risk Assessment. 8. Sustainability. 9. Product Safety Testing.	1. Chemical Hazard Communication. 2. National Chemicals Management Laws/Regulations. 3. Consumer Product Regulations. 4. Cosmetic/Personal care Products Regulations. 5. Food Packaging/Food Contact Laws and Regulations. 6. Pesticides/Biocides/Plant Protection Products Regulations. 7. Sector of Use Regulations and Expectations. 8. Dangerous Goods Transportation Regulations. 9. Banned/Restricted Substances Regulations.	1. Individual Effectiveness. 2. Teamwork. 3. Management. 4. Business Acumen.
Adapted from: *Core Competencies for the Product Stewardship Professional*; Product Stewardship Society, 2014; www.ProductStewards.org. [28]		

Green Chemistry

With the seemingly endless quantities of chemicals used around the world, public attention has often been focused on the adverse effects to environmental and public health from those very same chemicals emanating from their respective production and manufacturing processes. The Green Chemistry movement aims to transition Society to more eco-friendly products that use less energy, benign starting materials and generate less waste. Table 10 illustrates twelve enabling-principles [2].

Table 10

The Twelve Principles of Green Chemistry	
1. Prevention	2. Atom Economy
3. Less Hazardous Chemical Syntheses	4. Designing Safer Chemicals
5. Safer Solvents and Auxiliaries	6. Design for Energy Efficiency
7. Use of Renewable Feed Stocks	8. Reduce Derivatives
9. Catalysis	10. Design for Degradation
11. Real-time Analysis for Pollution Prevention	12. Inherently Safer Chemistry for Accident Prevention

When anticipated construction-related chemical exposures are addressed during initial design (redesign) guided by the chemistry principles listed above; health gains, environmental benefits and cost savings can be maximized.

Conclusions

Blending the pillars of sustainability with green construction practices makes good business sense on many levels. NIOSH and others have been a driving force behind collecting, analyzing, disseminating and integrating construction research and training outcomes that have lead to occupational health and safety advancements such as the Total Worker Health™ Program and Prevention through Design. The USGBC and NIOSH have also partnered in this arena via the LEED PtD pilot credit program. Three sustainability models were presented: Concentric, Hierarchal and Cyclic. The models were created to help visualize the inter-relationships and potential synergy. Green buildings constructed with non-toxic materials (via the PtD approach) will very likely reduce downstream health and safety issues for the future occupants throughout the structure's life cycle. Product Stewardship was established to responsibly manage the health, safety and environmental aspects of raw materials, intermediates, and consumer products in order to prevent or minimize negative impacts and maximize value. Construction companies, large and small, that can successfully harmonize sustainability practices into their day-to-day operations will have a competitive edge going forward in their pursuit of organizational excellence.

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