مدیریت پروژه‌های صنعت ساخت

(ساختمانی، زیرساختی و صنعتی)

فصل دهم: مدل‌سازی اطلاعات ساخت (BIM)
مبانی و مفاهیم BIM در مدیریت ساخت

ارائه دهنده:

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What we will learn?

- Introduction to BIM
- BIM evolution
- BIM implementation
- Designing with BIM
- BIM execution planning
- BIM execution career
- Using BIM to manage construction
- Advances on the horizon
- CM roadmap related to this section

INTRODUCTION TO BIM

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Introduction

- Everything we do in **construction management** is tied to the plans and specs.
- They provide the benchmark by which a **contractor's performance is measured**.
- The plans and specifications make up **two of the key components** of the **construction contract**.
  - However, one of the most exciting advances in construction over the past few decades is the ever-increasing use of **Building Information Modeling or BIM**.

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Our goal

- It is **not the intention** of this section to explain the technical aspects of **how BIM works** from a **model building perspective**.
  - Instead, you will learn a few ways in which **BIM is utilized** to support the various construction management functions.

BIM definition

- Fundamentally, **BIM** adds a three-dimensional "modeling" component to traditional two-dimensional **plans** and **specifications**.
- **Every element** of the design displayed in the building information model also carries with it data to **support a whole array** of **construction management** tasks and activities.

BIM model
A digital representation of the physical and functional characteristics of a building displayed as a 3D model, with the added capability to integrate a whole array of design and construction data related to cost, schedule, materials, assembly, maintenance, energy use, and more.

BIM definition

- As such, a **BIM model** serves as a **shared knowledge resource** for the entire design and build team.

- BIM focuses on the **integration of information** that inevitably
  1. Adds **efficiency** to the design and construction process,
  2. Reduces waste and error, and
  3. Improves quality

BIM definition

To better appreciate the **significance** that the merger of 3D representation and data has made on the **design and construction industry**,

let's take a look at **how modeling technology** has evolved and where it is today.

BIM EVOLUTION

Evolution of modeling

- Many **decades ago**, architectural plans and specs were created the **"old-fashioned" way—with pen, pencil, and paper**.

- If you **needed to make a change** to some part of a document,

  it meant getting out the electric erasers and redrawing the plan, section, or detail that needed changing.

- And if that **change impacted** other elements of the design,

  then you'd have to manually go in and modify the other drawings as well,

  thus more erasing and redrawing.

Evolution of modeling

- Everything is **now produced electronically** on a computer.

- It's very likely that your old set of rolled up paper drawings have been replaced by a computer tablet that displays your **digital plans on a screen**.

- We **still depend** on the plans and specifications to guide us through the building process, but **how those plans** are produced has changed, and continues to evolve.

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Computer Aided Drafting (CAD)

- In the **early 1970s**, computer-aided drafting (CAD) started making its way into the marketplace.

- As exciting as this **technology was**, at first it was able to run only on **graphic terminals** connected to **mainframe computers**.

- But in the early 1980s, CAD programs that were able to run on **personal computers** began to emerge, and

  it **started to show up** in the offices of some architects around the country—and, oh, what an improvement!

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Computer Aided Drafting (CAD)

- But as **wonderful as CAD** is, even with 3D modeling capabilities,

  it isn't BIM.

  In other words, the model that is produced via CAD isn't intelligent.

- It is simply a 3D representation of a 2D design.
  - *For example, the **3D model** is **not able to detect errors** on its own and correct information*

    from one part of the model to another part of the model automatically.

Building Information Model (BIM)

- While **CAD is a technological modeling tool** that can accurately depict a facility in 3D perspective,

  the **concept of BIM** goes way beyond the 3D capability.

- **BIM** is a database-driven modeling system that is **designed for collaboration**.
- The model is dynamic and can integrate the design, building, and documentation process across a **project's lifespan**.
- The key difference between a three-dimensional CAD model and a BIM file is that **each element** within the BIM file comes **with information attached**.

*BIM has been a **breakthrough technology** for the construction industry,*
*but there's even **more great improvements and innovations** to come.*

Virtual Design and Construction (VDC)

- **Although VDC** is sometimes used synonymous with BIM,
  they **aren't really the same** thing.

- The **easiest way** to describe VDC is to reference how construction companies are using it **currently**.

Virtual Design and Construction (VDC)

- For example, **Mortenson Construction**, a large national commercial firm known for its aptitude in technology use, describes BIM and VDC as follows:

1. **BIM is a "noun."** BIM has two attributes.
   i. The first is the **geometry or 3D object**.
   ii. Second is the **associated data** of the object, like the manufacturer specifications, size, and location.
      - ✓ Together, they form **smart objects**.

        So, if the **data changes**, the geometry changes with it, and vice versa.

Virtual Design and Construction (VDC)

- For example, **Mortenson Construction**, a large national commercial firm known for its aptitude in technology use, describes BIM and VDC as follows:

2. **VDC is a "verb" used to represent acting on the BIM.**
   - VDC is simply a **visual management methodology**

     using BIM as part of the construction analysis work,

     such as performing a lighting or engineering analysis.

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VR vs. VDC

NOTE

Virtual design and construction should not be confused with virtual reality. VR and VDC are not the same thing. The use of the word "virtual" in VDC is misleading in that it implies that VDC is a digital software and it is not. Virtual reality is an artificial environment which is created by software and experienced through sight and sound provided by special equipment.

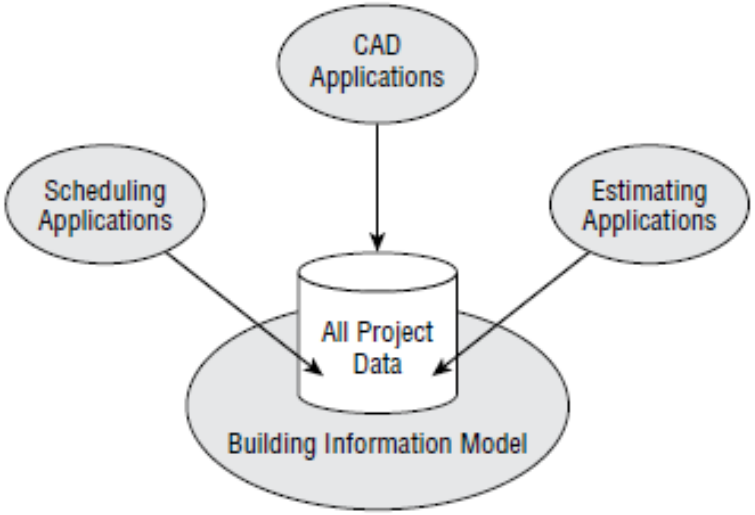
BIM IMPLEMENTATION

Implementing BIM

- There are two basic approaches to implement BIM:
  1. Central repository approach
  2. Distributed repository approach

Central repository approach

- One approach assumes that **all project information** can be loaded into one database to create a single package BIM.
  - *For example, all **estimating data and scheduling data** would be merged with or added to **data comprising the 3D model**.*



Central Repository Approach

central repository approach
The concept that all project information can be loaded into one database to create a single building information model.

Central repository approach

- This approach, referred to as the central repository approach, is considered impractical by many in the construction industry,

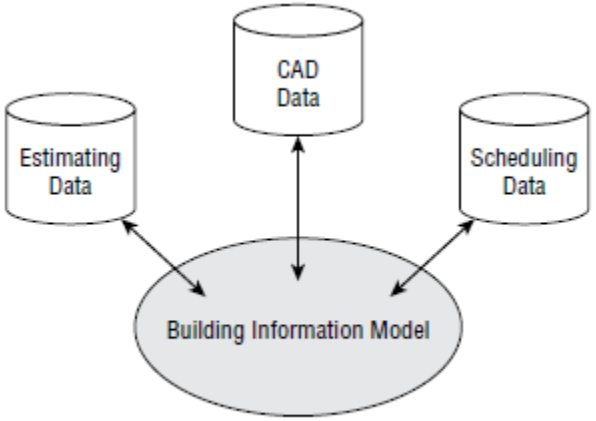
  at least at **this stage of the BIM evolutionary** process.

- One **common reason** for this is that the architects and contractors need different types of information to do their work.
  - Whereas architects may need **energy use and building code data** to design spaces and calculate heating and cooling requirements,

    contractors need **cost data and activity durations** to do their estimates and schedules.

Distributed repository approach

- The second approach, known as the distributed repository approach, is the path that **most** contractors, subcontractors, and sub-consultants have **taken** to implement their BIM activities.
- With this approach, the BIM model has access to a **collection of separate databases** maintained within their independent programs.



Distributed Repository Approach

distributed repository approach
The concept that the BIM model consists of a collection of separate databases maintained within distinct programs that can communicate in a way that allows them to exchange at least some of their data.

Distributed repository approach – Example

- For example, **all of the estimating data** needed to perform cost computations and the like are maintained in the estimating program.
- The estimating program is then able to **exchange some of its data** with the 3D BIM model via a bi-directional link (back-and-forth exchange)

  to **create an estimate** for the project.

  - This can all happen at the **preliminary design model stage**.
- What **makes this exchange possible** is a property known as interoperability, and it is really the **key to integrating all** of the independent-discipline databases

  to produce the **various BIM deliverables**.

Interoperability
The capability of a system or program to interact with other systems or programs without access or implementation limitations or restrictions.

BIM implementation

- The **fact is**, at this point in time, **no one BIM tool** can do everything.

- It is not at all unusual for the **various disciplines** (architectural, structural, mechanical, electrical, plumbing, and others)

  to **create their own models**, in a distributed fashion, and

  then **use other software applications** (such as Navisworks) to create a composite model

  that allows for **clash detection and other types of construction coordination** exercises and constructability reviews.

BIM implementation

NOTE

Building information modeling is being taught as part of the standard construction management education program at many universities across the United States. What is especially encouraging is that this technology, designed to integrate information, is bringing about more collaboration among students from the different design-build disciplines of construction, planning, architecture, engineering, and even facilities management and landscape architecture. Students learning this technology have an advantage when applying for jobs as more companies are seeking employees with this added capability.

DESIGNING WITH BIM

Introduction

- With BIM, the **design process** begins by building a model made up of intelligent objects that **represent all the elements** of the project—walls, roof, windows, beams, stairs, air conditioning units, and so on—
  that know what they are and what relationship they have with the other objects in the model.
- The **object** knows everything about itself—
  its size, frame material, type of glass, R-value, and so on.
- If you **change the design**, each object will adjust itself to fit the new scheme.

Level of Development (LOD)

- Just as traditional plans and specs are prepared to **various levels of detail** at **different stages of the process,**

  to convey the overall design intent and information about construction,

  so too will a **BIM be developed** to various stages of specificity.

- As you learned back in this course,

  there are basically **four steps** to the traditional design process **after the programming stage**—

  schematic (or conceptual) design, design development, construction documents, and as-builts.

Level of Development (LOD)

- With BIM, the **various stages of design** are

  classified as level of development or LOD stages.

- In addition to displaying the geometric information and features of the design, the LOD also defines
  1. **Data** and **information** associated with the **model elements**
  2. **Reliability** of them, at the **different stages of the process**

Each LOD is identified by a number

Level of Development (LOD)

General depiction of various LOD stages

Level of Development (LOD)

- The standard LOD "classes" are:

1. LOD 100—Concept Design

- At this stage the model is developed to a very basic level with little to no geometric information provided (e.g. dimensions).
- However, elements such as overall area, height, volume, location, and orientation are **defined**.

Level of Development (LOD)

- The standard LOD "classes" are:

1. LOD 200—Schematic Design

- At this stage, a general model is created, with a little more information added.
- Geometric information is provided such as configuration, size, and shape, as well as related informational elements such as approximate quantities.
- In addition, non-geometric information such as location and orientation **may be included.**

Level of Development (LOD)

- The standard LOD "classes" are:

3. LOD 300—Detailed Design

- This stage represents an accurate model with **shop drawing level elements** with specific assembly detailing, precise quantities, configurations, sizes, shapes, location, and orientation.
- Additional non-geometric information can also be attached to the elements at this stage such as **cost data** for pricing.
- The accuracy of the measurements, locations, quantities, and other pertinent data is **reliable** and can now support various construction management processes such the **estimating**, **budgeting**, and **job cost accounting**.

Level of Development (LOD)

- The standard LOD "classes" are:

4. LOD 350—Construction Documentation

- This level adds a little more detail to the model, which allows for **cross-trade coordination**

  to aid with the interfaces between the **various building elements** and **disciplines**.

Level of Development (LOD)

- The standard LOD "classes" are:

5. LOD 400—Fabrication and Assembly

- This level provides **detailing** for fabrication and assembly purposes at the **trades level.**
  - ✓ For example, this stage is **when a contractor can begin to split up components** of the detailed model to assign to different subcontractors to perform their work.

Level of Development (LOD)

- The standard LOD "classes" are:

6. LOD 500 – As-Built

- This stage of the model provides reliable building geometry, data, and information to **support** the facilities, operations, and maintenance functions.

BIM EXECUTION PLANNING

BEP

- Because there are **many team members**, from both design and construction, and maybe even operations and facilities personnel, who will be relying on the BIM to plan, coordinate and execute their work,

  it **only makes sense** that a great deal of upfront planning has to go into building the model itself.

- To start, it's **key that all parties understand** the difference between a design intent model, a construction model, and a facilities management model.

- Knowing how the model will be used is pretty fundamental to the BIM Execution Planning process.

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BEP

- It is also very important that **everyone** creating, inputting information, and using the BIM be on the **same page**.

- Establishing rules and standards is the primary reason for having a BIM Execution Plan in the first place.

- **Even** if you have nothing to do with the building of the BIM, and are only a user, you **still need to understand** how it was built and to what levels of development various aspects of the model were created.

BIM EXECUTION CAREER

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BIM CAREER

- Although some contractors, especially the **smaller firms**,
  often rely on third party consultants to develop their BIMs,
  we are seeing **more and more companies train** their own modelers, and
  create new positions associated with the BIM planning task.

- **BIM Management** has emerged as one of the newest construction management career paths.

BIM CAREER

- In response to the need for BIM managers, the Associated General Contractors (AGC) has created an **educational offering**

  for those who want to earn a Certificate of Management in Building Information Modeling (CM-BIM).

- According to the AGC website, the CM-BIM is an assessment-based credential

  that denotes knowledge and understanding of **concepts** related to BIM adoption,

  practice and process transformation outlined in the **AGC BIM Education Program.**

BIM CAREER

CMAA **standard of practice** is **written to maximize** the role of the CM in the BIM process, **consistent** with the **CM's traditional role** on a project, and to afford the **CM** the opportunity to take the *lead* in the overall process as BIM continues to mature and evolve.

- The CM is a central information hub for the project, **but**:
  - How CM should **implement BIM** in **different project delivery systems**?
  - What is the **role of CM** in different project delivery system?
  - What are the **CM's contractual obligations**?
  - What are the **owner expectations**?

The CMAA's standard for BIM highlights the unique and integral role of the CM in representing project owners in utilizing BIM effectively.

USING BIM TO MANAGE CONSTRUCTION

Collaboration

- Although **architects and engineers** are often identified as the primary beneficiaries of BIM,

  the truth is the **construction industry** has a **great deal to gain** from employing BIM technology as well.

- With BIM you get a chance to **build the project in a virtual environment** before you build it for real.

- BIM provides an **extraordinary opportunity** for contractors to

  plan their construction approach, methods, and means

  long before they ever break ground.

Parties

- The entire build team (contractor, subcontractors, fabricators, and so on) can work together **collaboratively**

  in a virtual construction environment to consider numerous scenarios

  relative to work sequencing, staging layouts, hoisting options, and many other important construction and job site management issues.

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Companies

- **Most commercial construction companies** have made the investment in the necessary **technology and training** and

  have incorporated **at least some elements of BIM** into their businesses.

- This is **good news** for members of the younger, tech-savvy generation who plan to enter the **construction industry.**

- **All construction management activities** can be enhanced and optimized through the use of BIM, and it can be applied to any type of construction project—**big or small.**

AGC

It has been reported by the Associated General Contractors that the 2D conversion to BIM for a typical project should take between one to two weeks and should cost between 0.1 percent and 0.5 percent of the total construction costs. This assumes that the contractor has already made the initial investment in software and training and is past the initial learning curve. Some contractors are outsourcing the task to a growing number of third-party service providers.

Models

design-intent model
A building information model prepared by an architect, primarily intended to communicate design information.

construction model
A building information model, typically prepared by a contractor, that links construction-specific information such as work breakdown structures and cost data to project elements in the 3D model.

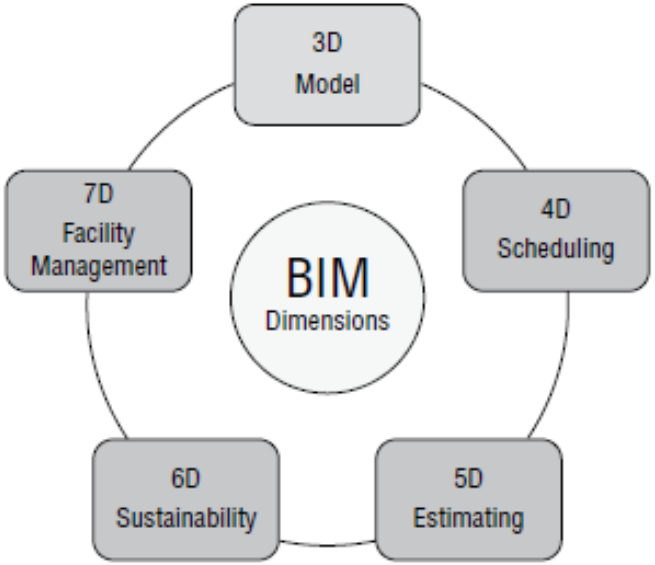
Benefits

- Design visualization
- Design assistance and constructability review
- Site planning and site utilization
- Integration of subcontractor and supplier data
- System coordination
- Layout and fieldwork
- Prefabrication
- Scheduling and sequencing (4D BIM)
- Cost estimating (5D BIM)
- Sustainability (6D BIM)
- Facility management (7D BIM)

stereoscopic projection
A 3D video display or view of a computer-generated building information model. Stereoscopic 3D is not the same thing as augmented, virtual, or mixed reality.

clash detection
A process for effectively identifying unintended material or system interferences in a 3D project model.

Benefits



ADVANCES ON THE HORIZON

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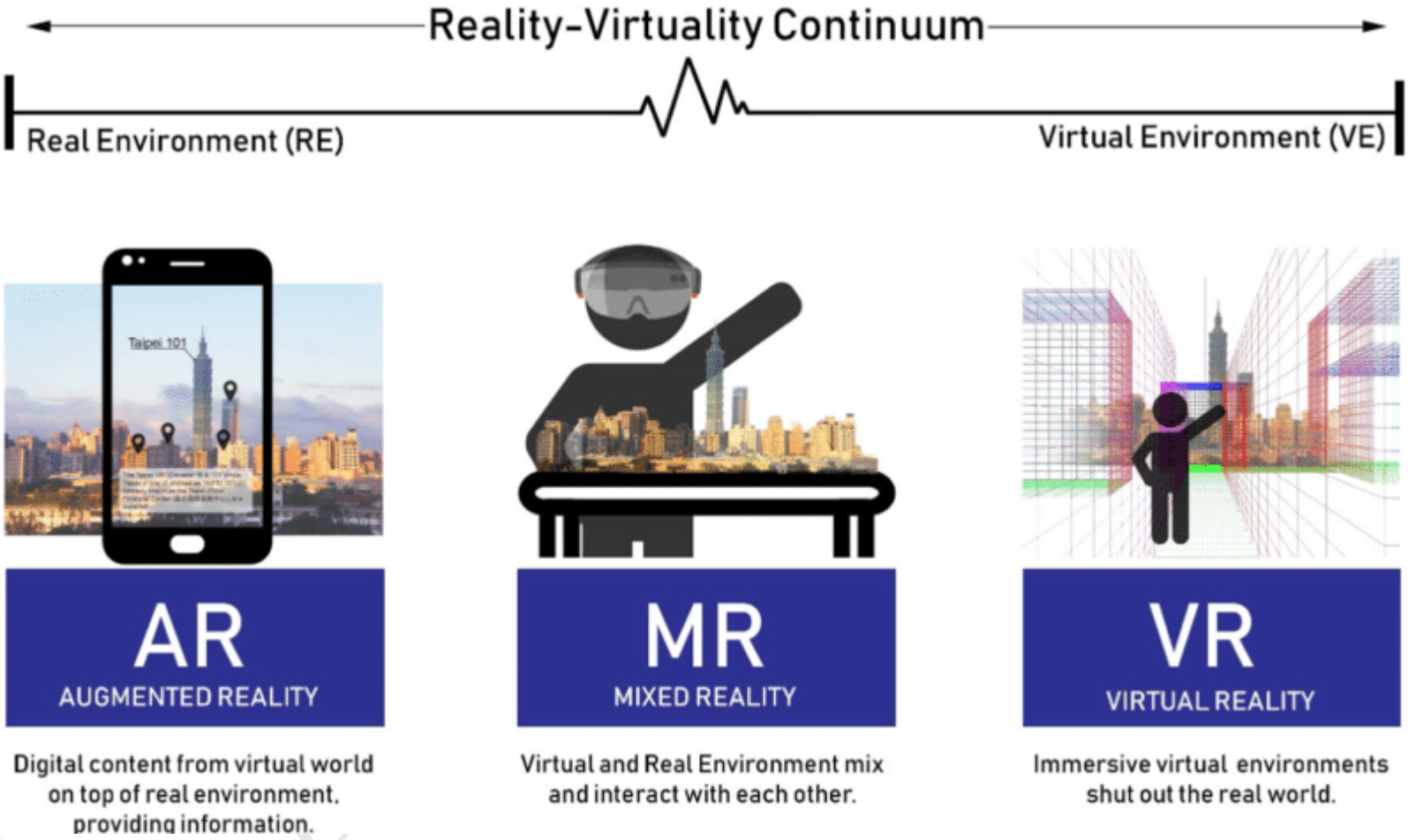
Advances

- We have certainly **come a long way** since the earliest days of CAD, but there's **still more to come.**
- Already on the horizon are **new groundbreaking technologies**, apps, and software that will add even greater capabilities to our **project teams and their work**.
- Although most applications are still in the early development and adoption stages, they are **gaining ground quickly.**
- Here's just a few that are making waves:
  1. Augmented reality
  2. Virtual reality
  3. Mixed reality

Advances



Advances

Augmented Reality
A technology that superimposes or overlays a computer-generated image on a user's view of the real world, thus providing a composite view.

Mixed Reality
Is the merging of the real world with virtual objects to produce new environments and visualizations where physical and digital objects co-exist and interact in real time. The object is anchored in the existing real environment.

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Advances

Virtual Reality
A computer-generated simulation of an artificial three-dimensional environment. Requires the use of special equipment to interact with the created environment such as goggles or gloves.

CM ROADMAP
RELATED TO THIS SECTION

CM Roadmap – Hard skills

مهارت‌های سخت (Hard Skills) - سطح کارشناسی و اجرایی

دپارتمان‌ها	سطح ۱	سطح ۲	سطح ۳	سطح ۴	سطح ۵
مدیریت پروژه	مدیریت پروژه‌های صنعت ساخت	راهنمای PMBOK	متدولوژی Prince2	استاندارد مدیریت ساخت CMAA	
مدیریت مالی و هزینه	مدیریت مالی و هزینه پروژه ارزیابی اقتصادی پروژه			تامین مالی پروژه	
مدیریت برنامه‌ریزی و زمان‌بندی	برنامه‌ریزی و کنترل پروژه نرم‌افزار MSP نرم‌افزار P6				
مدیریت کیفیت			مدیریت کیفیت پروژه		
مدیریت قرارداد	آنالیز تاخیرات پروژه	مدیریت ادعاء و اختلافات			اجرای پروژه به روش CM
مدیریت ایمنی			مدیریت ایمنی پروژه		
مدیریت طرح و برنامه		مدیریت پروژه به روش Lean دفتر مدیریت پروژه (PMO)	مدیریت چابک Agile		مدیریت طرح
مدیریت پایداری			مدیریت پایداری پروژه		
مدیریت ریسک		مدیریت ریسک پروژه			
مدیریت اطلاعات	مدیریت اسناد و مدارک پروژه	نرم‌افزار Power BI			
مدیریت مدل‌سازی اطلاعات ساختمان (BIM)		نرم‌افزارهای BIM		مدیریت BIM در پروژه	

Relevant comprehensive courses

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Relevant comprehensive courses

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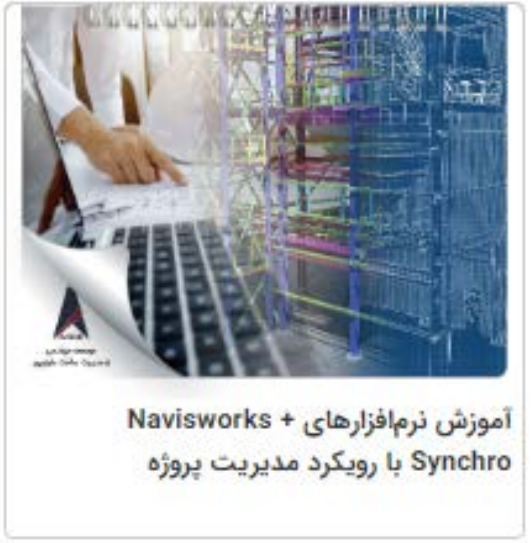

https://dralavipour.com/general-course/synchnavis1

Relevant comprehensive courses

BIM Management
Next years…

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CM Roadmap – Hard skills

مهارت‌های سخت (Hard Skills) - سطح ارشد استراتژی

دپارتمان‌ها	سطح ۱	سطح ۲	سطح ۳	سطح ۴	سطح ۵
مدیریت پروژه			منشور اخلاق در مدیریت پروژه		
مدیریت مالی و هزینه		استراتژی مدیریت هزینه و مهندسی ارزش			
مدیریت برنامه‌ریزی و زمان‌بندی		استراتژی مدیریت برنامه‌ریزی و زمان‌بندی			
مدیریت کیفیت				استراتژی مدیریت کیفیت	
مدیریت قرارداد	اصول مدیریت ساخت		استراتژی مدیریت قرارداد		
مدیریت ایمنی				استراتژی مدیریت ایمنی	
مدیریت طرح و برنامه					استراتژی مدیریت طرح و برنامه
مدیریت پایداری				استراتژی مدیریت پایداری	
مدیریت ریسک			استراتژی مدیریت ریسک		
مدیریت اطلاعات			استراتژی مدیریت اطلاعات		
مدیریت مدل‌سازی اطلاعات ساختمان (BIM)					استراتژی مدیریت BIM

Relevant comprehensive courses

https://dralavipour.com/video-course/web8

Relevant comprehensive courses

The list goes on…

CM Roadmap – Management skills

منتورینگ (Management Skills) - سطح مدیریتی

سطح ۱	سطح ۲	سطح ۳	سطح ۴	سطح ۵
پیش‌نیاز ورود	پیش‌نیاز ورود	پیش‌نیاز ورود	پیش‌نیاز ورود	پیش‌نیاز ورود
دارای مدرک کارشناسی در زمینه مهندسی	داشتن مدرک مدیریتی سطح ۱	داشتن مدرک مدیریتی سطح ۲	داشتن مدرک مدیریتی سطح ۳	داشتن مدرک مدیریتی سطح ۴
تسلط بر مباحث مهارت‌های سخت و نرم سطح ۱	تسلط بر مباحث مهارت‌های سخت و نرم سطح ۲	تسلط بر مباحث مهارت‌های سخت و نرم سطح ۳	تسلط بر مباحث مهارت‌های سخت و نرم سطح ۴	تسلط بر مباحث مهارت‌های سخت و نرم سطح ۵

مدیریت پروژه‌های صنعت ساخت

(ساختمانی، زیرساختی و صنعتی)

فصل یازدهم: مدیریت پایداری

مبانی و مفاهیم پایداری در مدیریت ساخت

ارائه دهنده:

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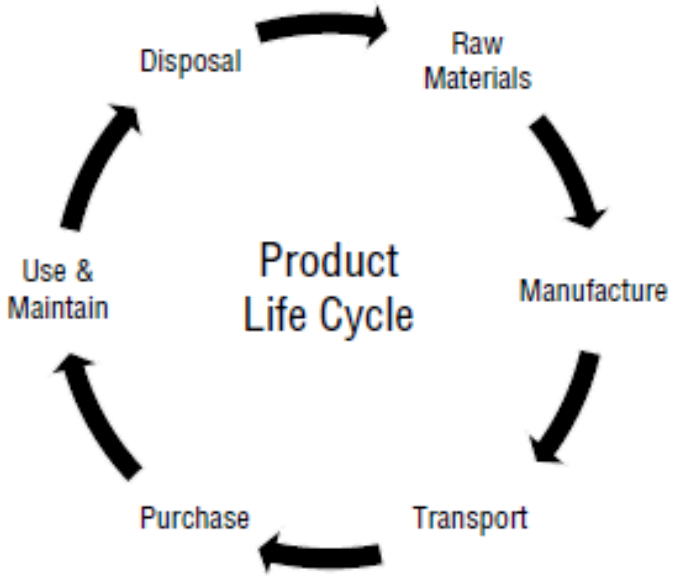
What we will learn?

- Building process lifecycle
- Introduction to sustainability
- Sustainable built environment
- Roles and responsibilities of project parties
- Sustainability standard
- Sustainability rating and certification systems
- CM roadmap related to this section

BUILDING PROCESS LIFECYCLE

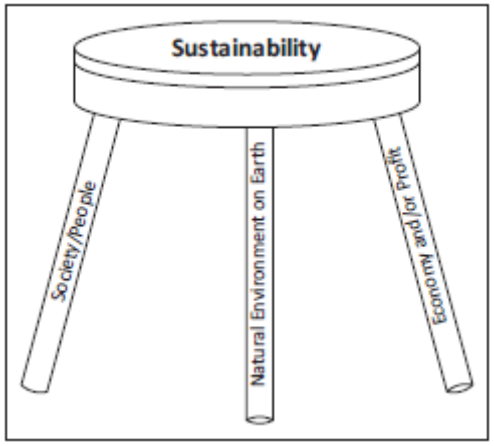
Process

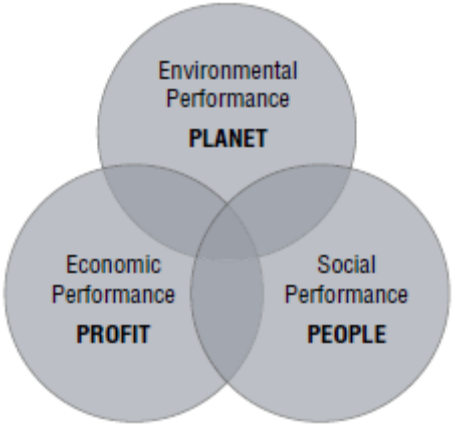


INTRODUCTION TO SUSTAINABILITY

Introduction

- **Sustainability** is often represented by a **three-legged stool**, often known as the triple bottom line, which is based on society, economy, and the natural environment.





Triple Bottom Line Sustainability

Introduction

- **Evaluation** of the sustainability of a project is a **difficult task**.
- Economic and environmental attainments are usually **quantifiable**,

  but **social attainments** are **difficult to directly link** to a built environment project and often cannot be quantified.
- Moreover, **construction firms** can only **minimally contribute** to the broader economic and societal attainments.
  - *Examples of this involvement include construction firms' efforts to **achieve economic soundness** by staying on budget, reduce societal impacts by **creating a safe and healthy work environment**, and **limit impacts on businesses and residents** affected by the **project construction**.*

Greenhouse gas (GHG)

- **Environmental sustainability** in the built environment can go beyond GHG emissions by considering other aspects, such as:
  - Reducing energy consumption and reliance on **fossil fuels**
  - Reducing the need for transportation of materials
  - Reducing water use and protecting natural resources
  - Minimizing air pollution and protecting air quality

Sustainability at large

- Before we focus on built environment projects, it is **paramount to introduce** the concept of sustainability at large.

- The following expression provides a good approach to introducing this concept:
  - *We do not inherit the earth from our ancestors; we borrow it from our children.*

(LEED 2009)

Sustainability ground rules

- The **term sustainability** pertains to many facets of life and is **not new to humanity**, but **its current meaning** is grounded in a **1987 report** of the United Nations (UN) World Commission on Environment and Development.

- At the time, the **commission** was chaired by
  1. **G. H. Brundtland** and included, as U.S. representative
  2. **William D. Ruckelshaus**, who had formerly worked under the Nixon and Reagan administrations

Sustainability ground rules

- This report, titled **"Our Common Future,"**

  but frequently referred to as the Brundtland Report,

  introduced the **concept of sustainable development**,

  which **provided the foundation** for what is now referred to as sustainability.

- Some **excerpts** from this report are included and commented on in this section to **provide a grounding** for policies and practices on sustainability in the **built environment** that will be discussed in the rest of this section.

Sustainability ground rules

The Brundtland Report introduces sustainable development as an objective for human development in the 21st century:

> *Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.*
>
> (UN 1987; sect. 27)

Sustainability ground rules

Sustainable development is proposed to create a worldwide integrated approach to deal with environmental, economic, and social change in the world:

> *The concept of sustainable development provides a framework for the integration of environment policies and development strategies… The pursuit of sustainable development requires changes in the domestic and international policies of every nation.*
>
> (UN 1987; sect. 48)

Sustainability ground rules

As defined, sustainable development does not mean stopping economic growth; instead, it means seeking a new type of growth that would allow meeting the needs and aspirations of future generations while addressing poverty and underdevelopment:

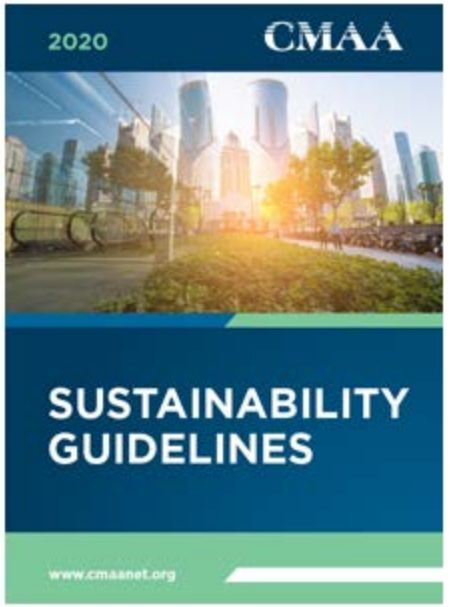
> *Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future. Far from requiring the cessation of economic growth, it recognizes that the problems of poverty and underdevelopment cannot be solved unless we have a new era of growth in which developing countries play a large role and reap large benefits.*
>
> (UN 1987; sect. 49)

SUSTAINABLE BUILT ENVIRONMENT

Sustainability keywords

Lifecycle

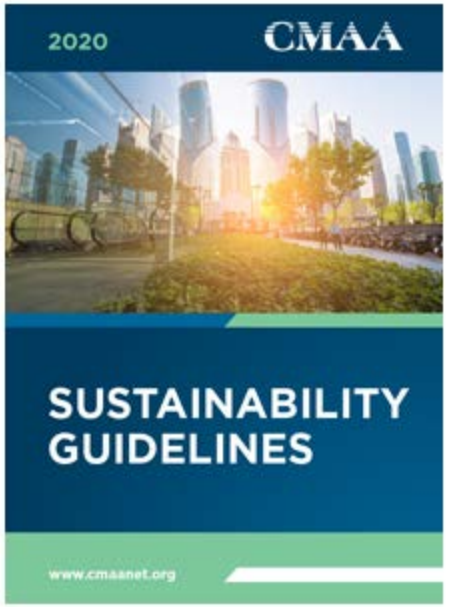
The consecutive, interlinked stages of a product's production and use, beginning with raw materials acquisition and manufacture and continuing with its fabrication, manufacture, construction, use, and depletion, concluding with any of a variety of recovery, recycling, or waste management options.



Sustainability keywords

Lifecycle Cost

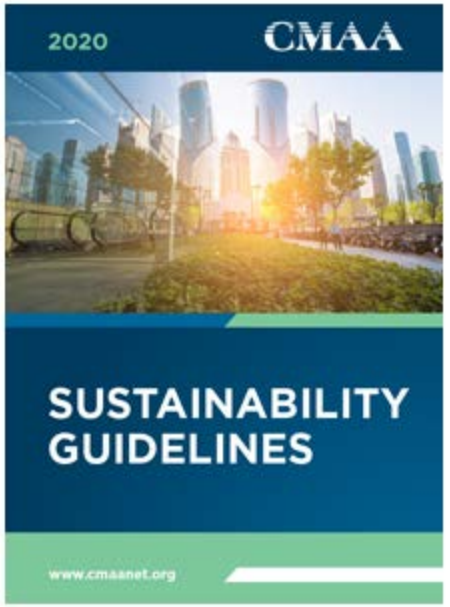
All costs incident to the planning, design, construction, operation, maintenance, and demolition of a facility, or system, for a given life expectancy, all in terms of present value.[xxxiv]



Sustainability keywords

Lifecycle Assessment (LCA)

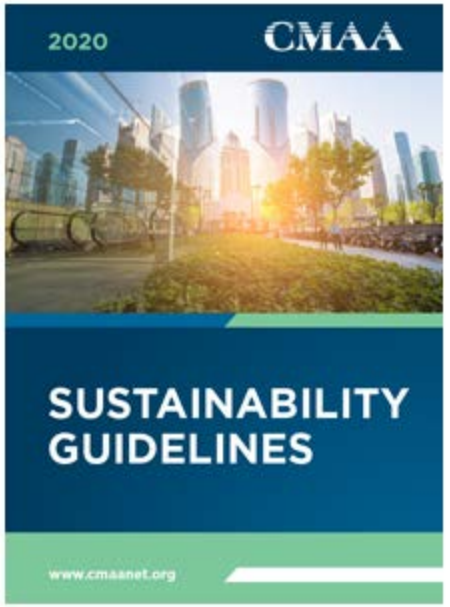
A technique to assess impacts associated with all stages of a product's life from cradle to grave (i.e. raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).



Sustainability keywords

Leadership in Energy and Environmental Design (LEED)

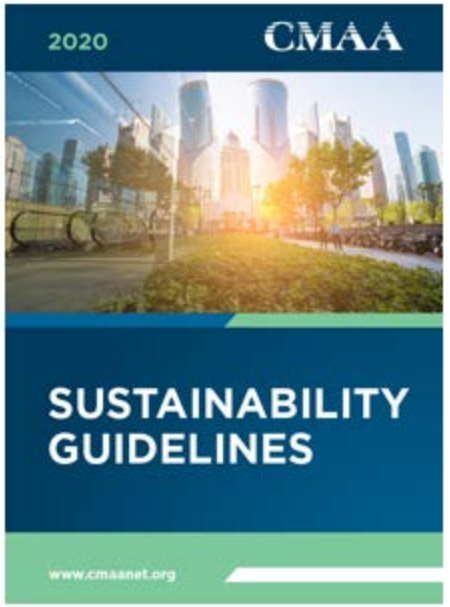
The Leadership in Energy and Environmental Design (LEED) green building rating system encourages and accelerates global adoption of sustainable green building and development practices through the application of design and construction and a graduated performance-based rating system with four increasingly rigorous levels of attainment: Certified, Silver, Gold and Platinum. LEED is a consensus guideline developed and administered by the Green Building Certification Institute.



Sustainability keywords

Sustainable Design and Construction

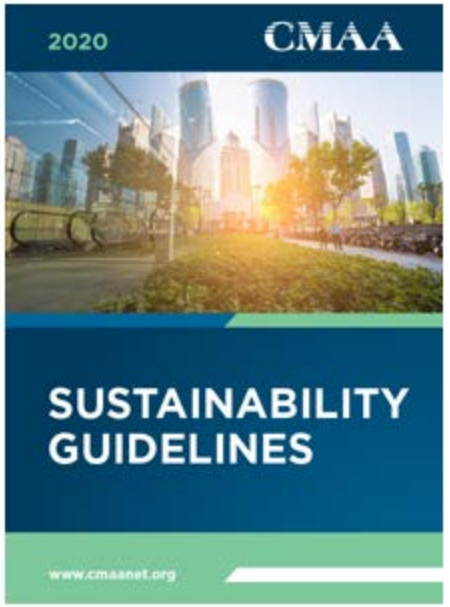
A type of construction project that has resource conservation and occupant health and well-being as primary objectives of the design, engineering and construction processes.



Sustainability keywords

Sustainable Development

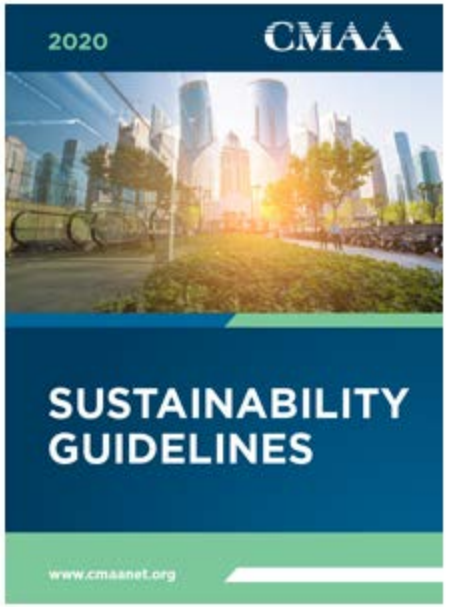
A pattern of resource use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for future generations. Sustainable development, as a goal, aims to reconcile the carrying capacity of natural systems with the physical, social and cultural demands of the system's occupants. As defined by the Brundtland Commission in 1983, sustainable development is "development which meets the needs of the present without compromising the ability of future generations to meet their own needs."



Sustainability keywords

Sustainable Materials

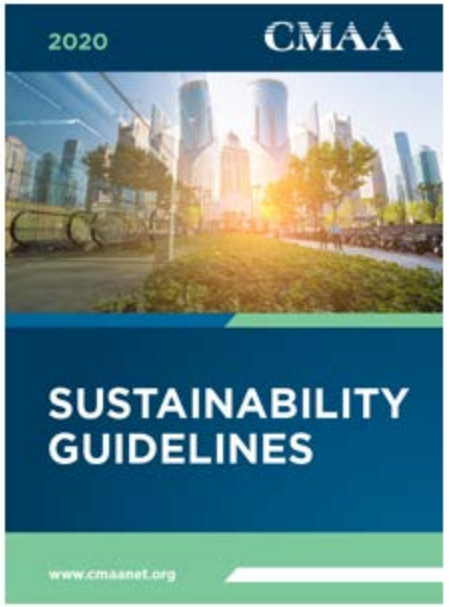
Sustainable building materials are composed of renewable, rather than nonrenewable resources. Sustainable materials are environmentally responsible when their impacts are considered over the life of the product. Use of sustainable building materials can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these source materials.[xxxviii]



Sustainability keywords

Sustainability Plan (SP)

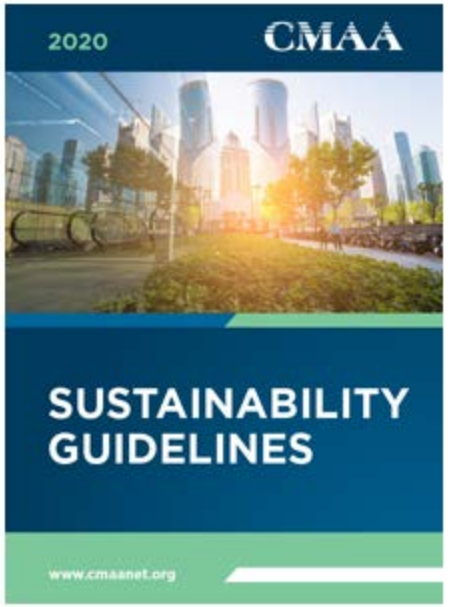
A project specific written plan that enables the construction manager to coordinate efforts, track progress and focus energies on the deliverables and milestones required to satisfy project sustainability goals and requirements. A sustainability plan is both a guidance document and the foundation for a reporting system. It should be as concise as possible.



Sustainability keywords

US Green Building Council (USGBC)

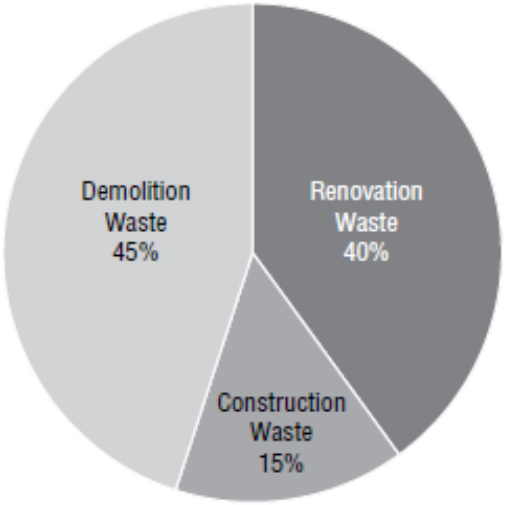
The US Green Building Council is a non-profit organization devoted to shifting the building industry toward sustainability by providing information and standards on how buildings are designed, built, and operated. The USGBC is best known for the development of the Leadership in Energy and Environmental Design (LEED®) rating system[xxxix].



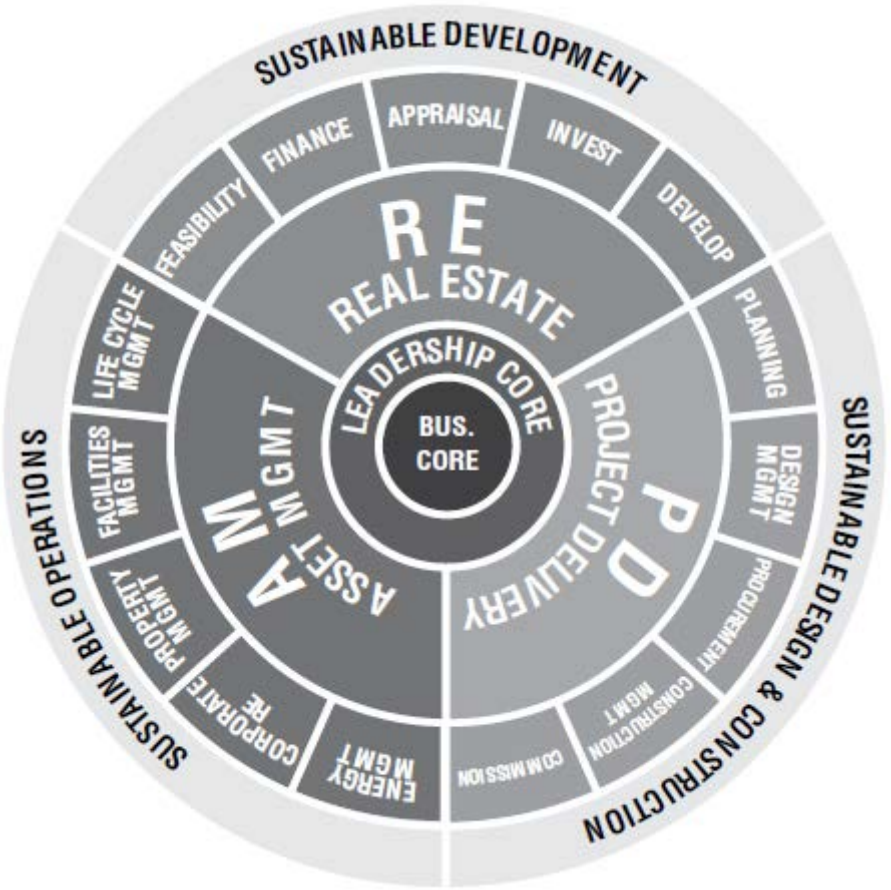
Sustainability needs

NOTE

New construction projects average 3.9 pounds of waste per square foot of building area. For example, almost 98 tons of waste is generated when constructing a 50,000-square-foot building. Building demolition averages about 155 pounds of waste per square foot, so a 50,000-square-foot demolition project would yield a whopping 3,875 tons of debris.



Sustainability needs



Sustainability built environment

- The **use** of renewable building materials is another important step toward sustainability.

- **Renewable materials** are those that can be reproduced at a rate that **meets or exceeds** the rate of human consumption.

Sustainability built environment

- There are **many options available** to architects and builders so that they can tailor a sustainable building to fit their clients' needs.

- **Some popular choices include:**
  1. Specifying heating, ventilating, and air conditioning (HVAC) systems that do not emit hydrofluorocarbon (HFC) and hydro chlorofluorocarbon (HCFC) gases
  2. Installing low-flow faucets and toilets
  3. Using light-emitting diode (LED) or compact fluorescent lamp (CFL) light fixtures that are on system timers
  4. Setting up a recycle program, both during construction and after close-out

Sustainability built environment

- Once a sustainable structure is built and the owner or tenants move in,

  it then **becomes extremely important** to operate and maintain the building sustainably.

- An example would be if the HVAC unit was not balanced or was not properly programmed to heat or cool the building.
- **Most contractors and subcontractors** are now offering owners maintenance packages or classes for facility managers.
- Several rating and certification programs that are discussed later in this section

  require the **building's owner** to **subject their projects** to checkups every one to five years to maintain their **sustainability rating**.

ROLES AND RESPONSIBILITIES OF PROJECT PARTIES

Design team

- **Some sustainable efforts** by the design team might include:
  - Identifying a **building orientation (i.e., location)** on the site that would **minimize energy consumption**
  - Enhancing **local energy generation**, such as using solar photovoltaic panels
  - Selecting **energy-efficient** HVAC and electrical systems
  - Specifying building **products and components**, such as operable and properly placed windows, to maximize

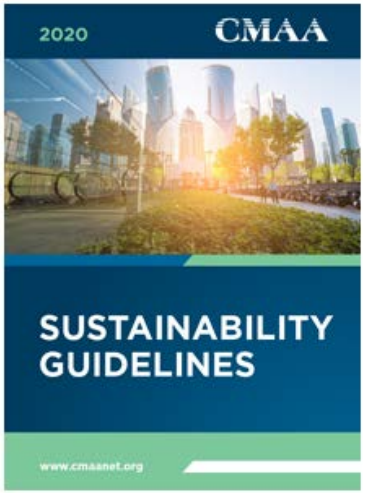
    natural lighting and ventilation, local building products requiring less driving and fuel consumption for deliveries, and materials that use less energy in manufacture and in end use
  - Incorporating **recycled materials** into the specifications

Construction team

- The **construction team's responsibilities** in producing a sustainable building include:
  - Demolishing or recycling materials in an **efficient manner**
  - Providing a **bus for craft workers** or vouchers for the public bus system
  - Reusing materials and minimizing **construction waste**
  - Using **recycle bins** and separating **materials** on the jobsite
  - Minimizing noise, light, and air pollution during construction
  - Protecting and restoring the natural environment
  - Eliminating storm water runoff and soil erosion
  - Selecting construction materials with high recycled content
  - Providing the exact products specified by the design team
  - Tracking all paperwork to support the materials installed and processes used

Construction manager

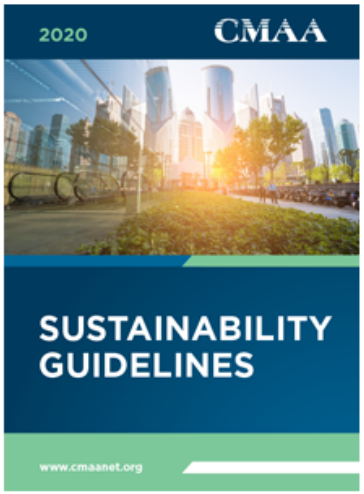
- The **CM's primary tools** to meet scope, schedule, budget, and quality control objectives should be clearly articulated in the Project or Construction Management Plan and its component or subordinate elements.
- The following strategies for integrating sustainability requirements are suggested:
  - Sustainability plan
  - Commissioning plan
  - Quality management plan
  - Construction procurement plan
  - Project safety plan
  - Contract administration procedures
  - Project management plan
  - Management information systems



SUSTAINABILITY STANDARD

Sustainability keywords

Sustainability Guidelines



CMAA
202 pages | ©2020

This CMAA Sustainability Guidelines document is a supplement to the sustainability chapter of the CMAA Construction Management Standards of Practice. It provides construction managers (CMs) with practical guidance in sustainability for conducting their responsibilities from project conception through to post-occupancy activities.

These guidelines include updated information on energy, climate adaptation, and resiliency planning. New projects and programs require CMs to keep current with the evolution of sustainability and how it may impact their clients, projects, and programs.

World events continue to affect the industry, and CMs must be prepared to adapt by embracing technological advancements such as improved virtual communication that allow projects to stay on track with minimal impact. A CM's guidance is also crucial for promoting and championing evolving safety practices while managing all aspects of a project.

ACEMI

Standards

- The **majority of students** graduating from community colleges and four-year university programs where construction management is being taught are most likely **pretty familiar** with the Leadership on Energy and Environmental Design (LEED) program, developed by the U.S. Green Building Council (USGBC).

- LEED is a voluntary, market-driven building-rating system that **evaluates environmental performance** over a **building's life cycle**.

- The **program** is designed to encourage project teams to pursue LEED certification for their buildings.

Standards

- According to the USGBC website:

> LEED is the most widely used green building rating system in the world. Available for virtually all building, community and home project types, LEED provides a framework to create healthy, highly efficient and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement.
> https://new.usgbc.org/leed

ACEMI

Standards

- The **LEED program**, first developed in 1993,

  with a **mission to promote** sustainability-directed practices in the construction business, is **pretty impressive**.

- Its **widespread acceptance** and use account for a number of notable highlights.

- **Here are just a few shared by the USGBC:**

  1. Over 2.2 million square feet of building space is **LEED certified every day**.
  2. There are more than 90,000 projects participating in **LEED**, with at least 32,500 of those being **commercial projects**.
  3. LEED is in 165 countries and territories and works for **all building types anywhere**.

SUSTAINABILITY RATING AND CERTIFICATION SYSTEMS

LEED Certification

- Under the **LEED program**, buildings are evaluated against certification standards.

- According to the USGBC, all building types and **all building phases**, including new construction, interior fit-outs, operations and maintenance, and core and shell projects may achieve LEED certification.

LEED Certification

LEED Designations	
Designation	**Description**
BD+C **Building Design and Construction**	For new construction or major renovations; includes new construction, core & shell, schools, retail, hospitality, data centers, warehouses & distribution centers, and health care.
ID+C **Interior Design and Construction**	For complete interior fit-out projects; includes commercial interiors, retail, and hospitality.
O+M **Building Operations and Maintenance**	For existing buildings that are undergoing improvement work or little to no construction; includes existing buildings, schools, retail, hospitality, data centers, and warehouses & distribution centers.
ND **Neighborhood Development**	For new land development projects or redevelopment projects containing residential uses, nonresidential uses, or a mix. Projects can be at any stage of the development process, from conceptual planning to construction.
Homes	For single family homes, low-rise multifamily (one to three stories) or mid-rise multifamily (four to six stories); includes homes and multifamily low-rise and multifamily mid-rise.
Cities and Communities	For entire cities and sub-sections of a city. Using the Arc performance platform, LEED for cities projects can measure and manage their city's water consumption, energy use, waste, transportation, and human experience.
LEED Recertification	Applies to all occupied and in-use projects that have previously achieved certification under LEED – including BD+C and ID+C, regardless of their initial rating system or version.
LEED Zero	Available for all LEED projects certified under the BD+C or O+M rating systems, or registered to pursue LEED O+M certification. LEED Zero is for projects with net-zero goals in carbon and/or resources.

Commercial and institutional buildings

- **Once laws and building codes** are in place and the triple bottom line is penciled out, **owners, architects, and contractors** begin looking for ways to measure and verify sustainable construction practices.
- **Many organizations** have been created to help in the effort of measuring and verifying sustainable practices.
- For the commercial built environment, we will elaborate on the **Leadership in Energy and Environmental Design (LEED) program**, the Living Building Challenge, and Green Globes, which are common measurement methods.

Commercial and institutional buildings

- The Leadership in Energy and Environmental Design rating and certification system was created by the **United States Green Building Council (USGBC)**, a non-profit organization that was founded in 1993.

- The demand **for commercial buildings** to be **certified** as sustainable was so great that the **USGBC (the parent organization)** created the Green Building Certification Institute (GBCI).

Commercial and institutional buildings

- GBCI is a third- party organization that provides **independent review** of two programs:

1. The **certification** of green building projects, according to the **LEED rating and certification system**, and
2. The **training** of professionals in the industry toward achievement of LEED credentials.

Commercial and institutional buildings

- LEED was developed to help **building owners and operators** become more environmentally responsible and use resources efficiently.
- Certification of a building starts with the project owner's decision to pursue LEED certification early in the design process.
- As part of the registration process, the owner establishes goals for the project in each of **nine categories**.
- Buildings are certified via a scorecard and people are **accredited** through classes and a final exam.

Commercial and institutional buildings

- The **points** available for each category **vary from one type of project to another**.
- Once all the scorecards and paperwork are turned in by the **contractor**, the GBCI reviews them.

LEED Point Breakdown by Project Type

	New Construction	*Core & Shell*	*Schools*	*Retail*	*Hospitality*	*Data Centers*	*Warehouses & Distribution Centers*	*Healthcare*
Integrative Process	1	1	1	1	1	1	1	1
Location and Transportation	16	20	15	16	16	16	16	9
Sustainable Sites	10	11	12	10	10	10	10	9
Water Efficiency	11	11	12	12	11	11	11	11
Energy and Atmosphere	33	33	31	33	33	33	33	35
Materials and Resources	13	14	13	13	13	13	13	19
Indoor Environmental Quality	16	10	16	15	16	16	16	16
Innovation	6	6	6	6	6	6	6	6
Regional Priority	4	4	4	4	4	4	4	4
TOTAL POINTS AVAILABLE	***110***	***110***	***110***	***110***	***110***	***110***	***110***	***110***

Commercial and institutional buildings

LEED Gold Plaque

- Based on their scoring, buildings can achieve four different levels
- Certified (40– 49 points),
- Silver (50– 59 points),
- Gold (60– 79 points), and
- Platinum (80– 110 points).

- Certified or Silver rating is **easy** to achieve for an experienced designer and contractor team,

  whereas **Platinum is extremely difficult**.

- Once a building **attains a LEED certification**,

  the owner is provided with a **plaque** that can be placed in the building to **show the level of certification.**

Commercial and institutional buildings

- Professionals can also obtain **LEED credentials** through classes and examinations.
- There are three levels of credentials on five different focuses, as shown.

LEED Credential Levels

Level	*Credential*	*Specialty*	*Eligibility*	*How to Get it*
1	**Green Associate (LEED GA)**		No eligibility requirements	Pass LEED GA exam
2	**Accredited Professional (LEED AP)**	*Building Design + Construction (BD+C)* *Operations + Maintenance (O+C)* *Interior Design + Construction (ID+C)* *Neighborhood Development (ND)* *Homes (HOMES)*	LEED project experience strongly recommended	No previous LEED GA credential: (1) Pass combined GA + AP exam; (2) Pass GA exam then pass AP exam. Previous LEED GA credential: pass only LEED AP exam
3	**Fellow**		LEED AP who have acquired significant technical knowledge and skills	Voted in by peers

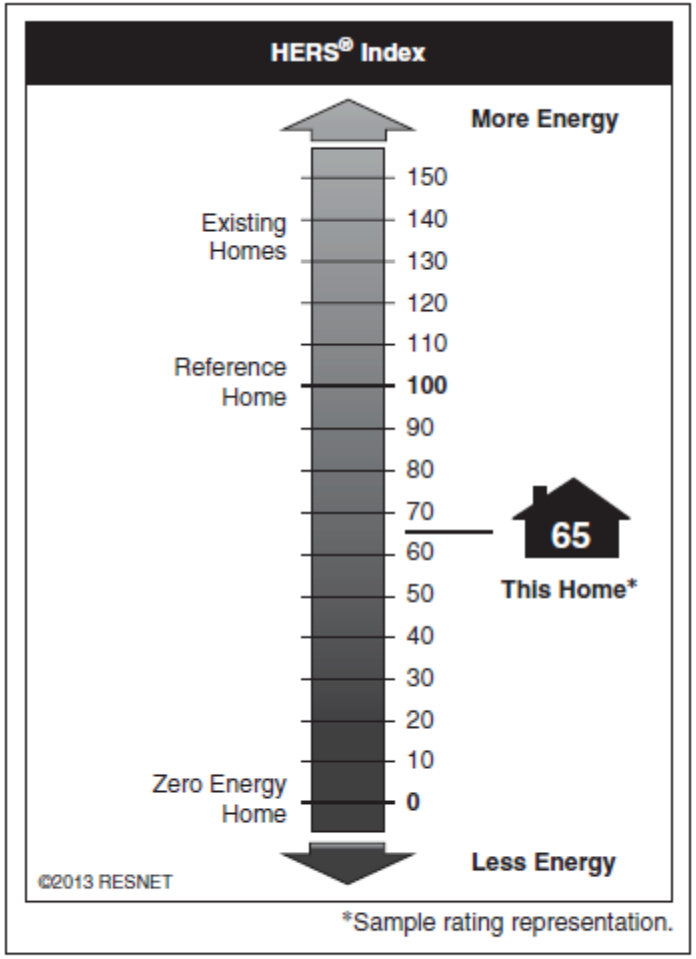
Residential buildings

- The National Association of Home Builders (**NAHB)** created the National Green Home Building Standard (NGHBS) for **residential buildings in 2007.**
- This rating system is for **new** and **remodeled** single- and multi-family homes and residential subdivisions.
- The **NGHBS rating system** focus is on:
  - Energy efficiency
  - Water conservation
  - Resource conservation
  - Indoor environmental air quality
  - Site design
  - Home owner education

Residential buildings

- The Home Energy Rating System (HERS) was developed by the **Residential Energy Services Network (RESNET)** in **2006**.
- The HERS index is another official verification system for energy performance in residential construction and is recognized by the Department of Energy, Department of Housing and Urban Development (HUD **as an industry standard**.
- A RESNET inspector tests and evaluates new and existing homes for energy efficiency.

Residential buildings



HERS Index
(Image courtesy: RESNET)

Infrastructure projects

- The Greenroads Rating System® was created by researchers at the **University of Washington** and adapts the **certification structure** of the LEED system to **transportation projects.**

- The system is currently managed by an **independent entity**, Greenroads International.

- This entity provides opportunities for sustainability education in the **transportation sector** and manages the certification process for **transportation projects** in the U.S. and internationally.

Infrastructure projects

- The **latest version** of this system allows projects to earn up to 61 credits:
  1. **12 mandatory credits** (i.e., "Project Requirements"),
  2. **45 voluntary credits** arranged in five Core Categories:
     (a) Environment & Water,
     (b) Construction Activities,
     (c) Materials & Design,
     (d) Utilities & Controls, and
     (e) Access & Livability
  3. **4 extra credits** that are available in a category called Creativity & Effort.

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Infrastructure projects

- Projects are assigned a **cumulative Greenroads** score depending on the points earned.

- Four certifications levels are currently offered:
  1. Bronze (40 points minimum)
  2. Silver (50 points minimum)
  3. Gold (60 points minimum)
  4. Evergreen (80 points minimum)

ACEMI

Infrastructure projects

- Another **rating and certification system**, known as Envision, is distributed and run by the Institute for Sustainable Infrastructure (ISI).

- This system evaluates projects against **60 sustainability criteria** to evaluate their **environmental**, **social**, and **economic** impacts.

- These criteria are organized into **five categories**:
    1. Quality of Life (13 credits)
    2. Leadership (ten credits)
    3. Resource Allocation (14 credits)
    4. Natural World (15 credits)
    5. Climate and Risk (eight credits)

ACEMI

Infrastructure projects

- Also, this system offers four certifications levels, which replicate those in the LEED system but with differing percentages:
  1. Bronze: To achieve at least 20% of points available
  2. Silver: To achieve at least 30% of points available
  3. Gold: To achieve at least 40% of points available
  4. Platinum: To achieve at least 50% of points available

CM ROADMAP
RELATED TO THIS SECTION

CM Roadmap – Hard skills

مهارت‌های سخت (Hard Skills) - سطح کارشناسی و اجرایی

دپارتمان‌ها	سطح ۱	سطح ۲	سطح ۳	سطح ۴	سطح ۵
مدیریت پروژه	مدیریت پروژه‌های صنعت ساخت	راهنمای PMBOK	متدولوژی Prince2	استاندارد مدیریت ساخت CMAA	
مدیریت مالی و هزینه	مدیریت مالی و هزینه پروژه ارزیابی اقتصادی پروژه			تامین مالی پروژه	
مدیریت برنامه‌ریزی و زمان‌بندی	برنامه‌ریزی و کنترل پروژه نرم‌افزار MSP نرم‌افزار P6				
مدیریت کیفیت			مدیریت کیفیت پروژه		
مدیریت قرارداد	آنالیز تاخیرات پروژه	مدیریت ادعاء و اختلافات			اجرای پروژه به روش CM
مدیریت ایمنی			مدیریت ایمنی پروژه		
مدیریت طرح و برنامه		مدیریت پروژه به روش Lean دفتر مدیریت پروژه (PMO)	مدیریت چابک Agile		مدیریت طرح
مدیریت پایداری			مدیریت پایداری پروژه		
مدیریت ریسک		مدیریت ریسک پروژه			
مدیریت اطلاعات	مدیریت اسناد و مدارک پروژه	نرم‌افزار Power BI			
مدیریت مدل‌سازی اطلاعات ساختمان (BIM)		نرم‌افزارهای BIM		مدیریت BIM در پروژه	

Relevant comprehensive courses

Sustainability Management
Next years…

https://dralavipour.com/general-course/sustainability-management

CM Roadmap – Hard skills

مهارت‌های سخت (Hard Skills) - سطح ارشد استراتژی

دپارتمان‌ها	سطح ۱	سطح ۲	سطح ۳	سطح ۴	سطح ۵
مدیریت پروژه			منشور اخلاق در مدیریت پروژه		
مدیریت مالی و هزینه		استراتژی مدیریت هزینه و مهندسی ارزش			
مدیریت برنامه‌ریزی و زمان‌بندی		استراتژی مدیریت برنامه‌ریزی و زمان‌بندی			
مدیریت کیفیت				استراتژی مدیریت کیفیت	
مدیریت قرارداد	اصول مدیریت ساخت		استراتژی مدیریت قرارداد		
مدیریت ایمنی				استراتژی مدیریت ایمنی	
مدیریت طرح و برنامه					استراتژی مدیریت طرح و برنامه
مدیریت پایداری				استراتژی مدیریت پایداری	
مدیریت ریسک			استراتژی مدیریت ریسک		
مدیریت اطلاعات			استراتژی مدیریت اطلاعات		
مدیریت مدل‌سازی اطلاعات ساختمان (BIM)					استراتژی مدیریت BIM

Relevant comprehensive courses

Strategy to Sustainability Management
Next years…

https://dralavipour.com/general-course/strategic-sustainability-management

CM Roadmap – Management skills

منتورینگ (Management Skills) - سطح مدیریتی

سطح ۱	سطح ۲	سطح ۳	سطح ۴	سطح ۵
پیش‌نیاز ورود	پیش‌نیاز ورود	پیش‌نیاز ورود	پیش‌نیاز ورود	پیش‌نیاز ورود
دارای مدرک کارشناسی در زمینه مهندسی	داشتن مدرک مدیریتی سطح ۱	داشتن مدرک مدیریتی سطح ۲	داشتن مدرک مدیریتی سطح ۳	داشتن مدرک مدیریتی سطح ۴
تسلط بر مباحث مهارت‌های سخت و نرم سطح ۱	تسلط بر مباحث مهارت‌های سخت و نرم سطح ۲	تسلط بر مباحث مهارت‌های سخت و نرم سطح ۳	تسلط بر مباحث مهارت‌های سخت و نرم سطح ۴	تسلط بر مباحث مهارت‌های سخت و نرم سطح ۵

موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)

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