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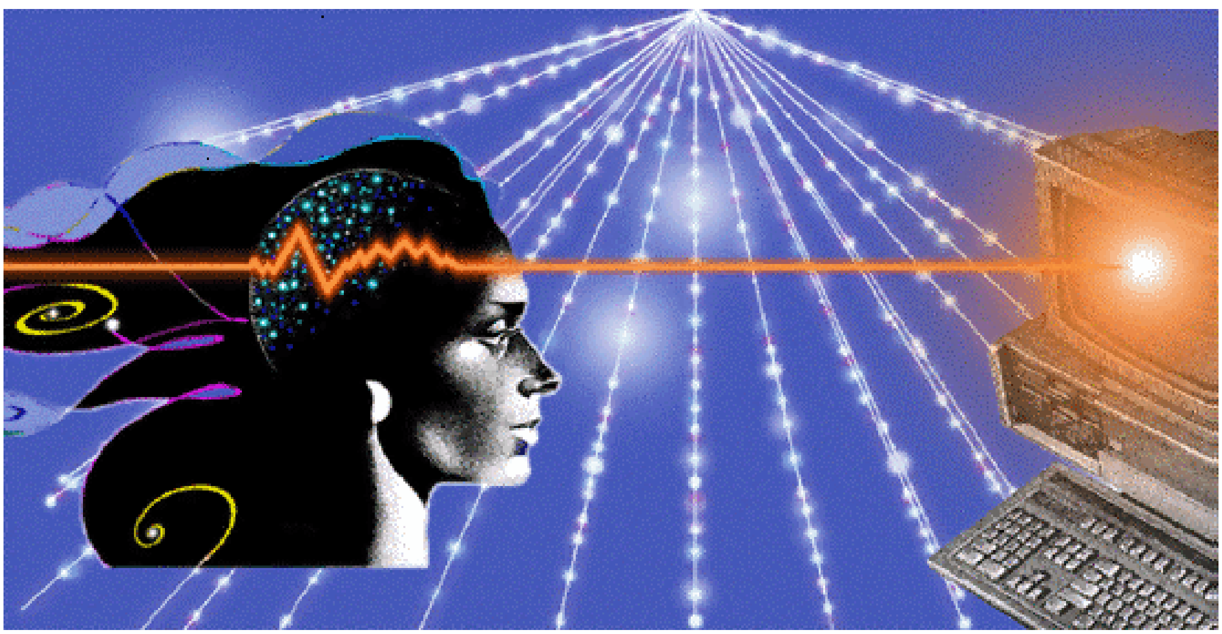

Engineering Automation Research Update

Annette L. Stumpf, editor http://www.cecer.army.mil/earupdate/index.cfm

Contents

Building Composer
Criteria-Based Facility Design

by Beth Brucker

Building Composer is a suite of tools for use by planners, designers, and engineers during the initial phases of facility planning and design. While originally developed to support the design of government facilities, Building Composer is based on the general concepts of: (1) providing a method to effectively and creatively create and use criteria libraries, (2) providing support for architectural programming and project specific criteria specification during interactive design charrettes or at the designer's desktop, and (3) supporting the creative and analytical aspects of architectural conceptual design involving the creation of one or many solutions from the specified criteria in an intuitive design environment.

While not enforcing any particular design process, Building Composer is designed to be able to support the iterative process shown in Figure 1,

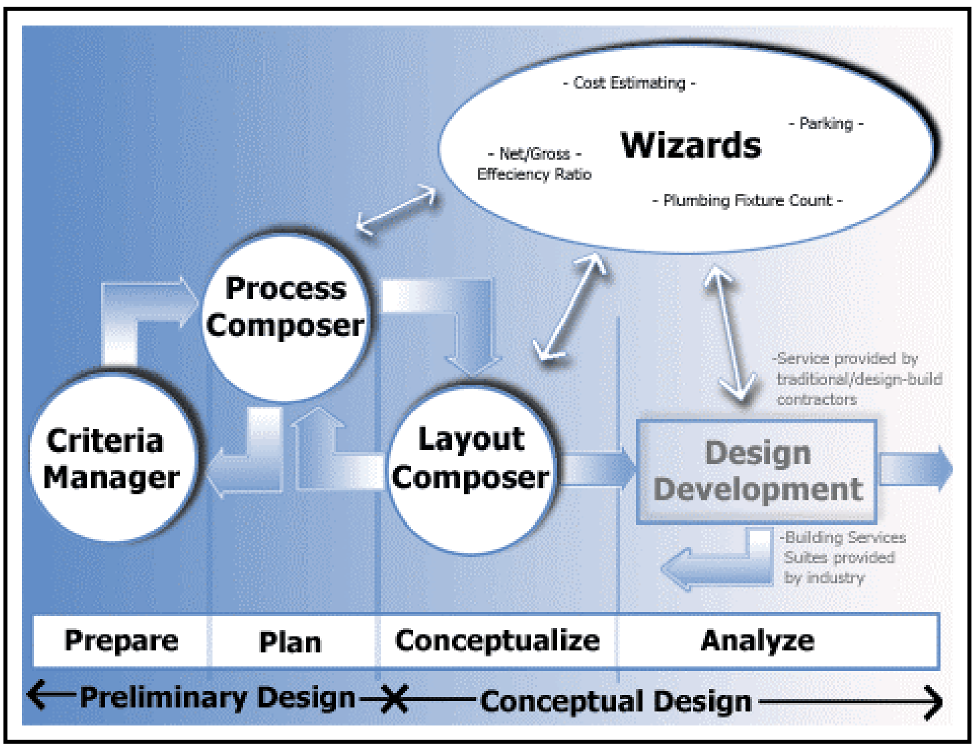

Figure 1. Process Flow of Building Composer Tools.

The most important concept of Building Composer is that customer-specific and computable criteria are associated with the facility model. While many volumes of government design criteria exist in the form of design guides, regulations, technical manuals, and web pages, few, if any, of these are expressed in a computable format. In addition, current design systems do not provide a way to directly interact with these criteria, nor do they provide an efficient way to extend the functionality of an application to directly support criteria usage.

In *Building Composer*, criteria can be associated to different project elements based on the appropriate level of detail, from the project to the site, the building, story, function, down to the individual space. For example, Building Composer allows one to specify that a target schedule and cost be associated to a project, that masonry exterior walls and a steel structure be used on a building, that 32-Watt T-8 florescent lights be used in corridors and 50 footcandles be maintained in the offices, and that a particular room will have VCT flooring. These criteria are then used to inspire and compare against during downstream design decisions. Building Composer's ability to maintain a linkage between criteria and project elements (site, building, story, etc.) provides many benefits:

- It helps ensure that critical criteria are followed, and that desired characteristics are recorded and addressed. It helps in defining criteria and can help in recording its rationale.
- It simplifies creation, maintenance, and distribution of new criteria. For example, as requirements that better implement sustainable design principles are developed, these are added to an organization's standard library for use in subsequent projects. These libraries are typically organized around facility type, but are not required to be.
- It helps support conceptual and detailed design & analysis (cost, structural, HVAC, energy, electrical, O&M, etc.) either directly or through standards, such as the *International Alliance for Interoperability's Industry Foundation Classes* (IAI-IFC) and *Building Lifecycle Interoperable Software* (BLIS).

Large owners, in particular, reap benefits from this approach as it helps ensure the initial design satisfies their corporate criteria, shortening the review process and avoiding "design by review." All of these benefits result in cost and time savings by reducing user changes late in the design process or during construction. Design quality is also enhanced, as many alternatives can be explored rapidly.

Tools

The primary tools in the Building Composer application suite include:

- Criteria Manager, a web-based application that helps in the development of corporate and building specific criteria libraries
- Criteria Composer, which helps users create an architectural program and to set values for project specific criteria
- Layout Composer that provides an environment for the user to create 3D conceptual facility designs
- Wizards that provide support for various discipline specific issues and assist in the completion of individual design tasks and calculations. Figure 2 shows how the Building Composer tools interact and how Building Composer and commercial-off-the-shelf (COTS) tools feed into the expanding facility model. These tools are described in more detail below.

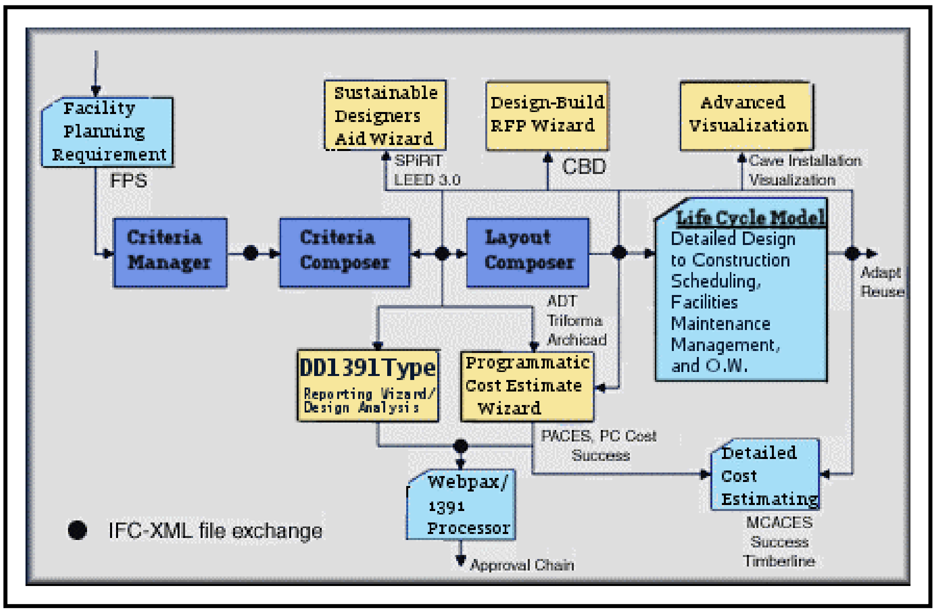

Figure 2. Building Composer Data Flow.

Criteria Manager

Building Composer relies on a customizable customer-specific library of architectural functions and criteria from which the architectural program is developed. Each customer will be able to create and customize these libraries using this web-enabled Criteria Manager application. Those authorized to use this tool can add new architectural functions, update their criteria, and notify interested parties. Criteria Manager will then export the criteria library in an XML-based format for use by the Criteria Composer.

Criteria Composer

Criteria Composer (Figure 3) is used to develop an architectural program and to add and set project specific criteria. This includes traditional information such as the total project area and allocation of area to specific architectural functions such as circulation and offices. It also contains discipline-specific criteria such as requirements for structural, electrical, HVAC, lighting, and plumbing. The level of detail in the architectural program varies from project to project, and can be specified as such in the system.

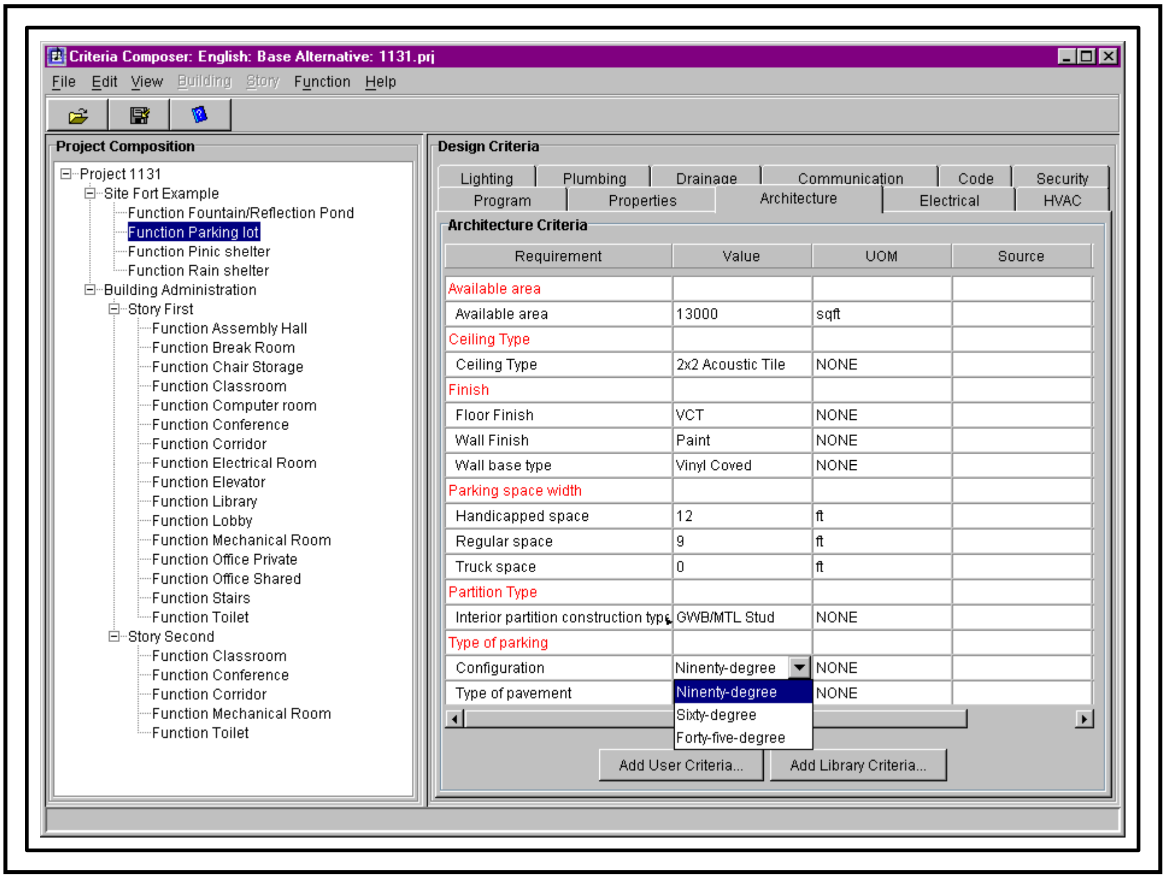

Figure 3. Criteria Composer.

With just a few parameters set, the information in Criteria Composer is sufficient to prepare a preliminary cost estimate and schedule. For example, it is acceptable to create a project that contains a list of architectural functions and their allocated areas without deciding how many buildings will be required. On the other hand, the planner may create a project with detailed information such as the number of buildings and the number of stories in each building. Obviously, the latter cost estimate will be more accurate. Typically, the planner will not create such a detailed program from scratch, but will copy it from a similar project and tailor it to suit the current customer's needs. Users benefit from Criteria Composer not only because it provides a method to capture, use, and reuse this explicit criteria, but also because it can often assist designers by providing a deeper understanding of the rationale behind certain decisions, from which other, better, solutions could be considered.

Once the architectural program has been completed, Building Composer will support a programming level cost estimate with preliminary cost estimating tools such as the Parametric Construction Cost Estimating System (PACES™) via an XML-based exchange file. In addition, other applications that comply with the IAI or BLIS standard can also be used.

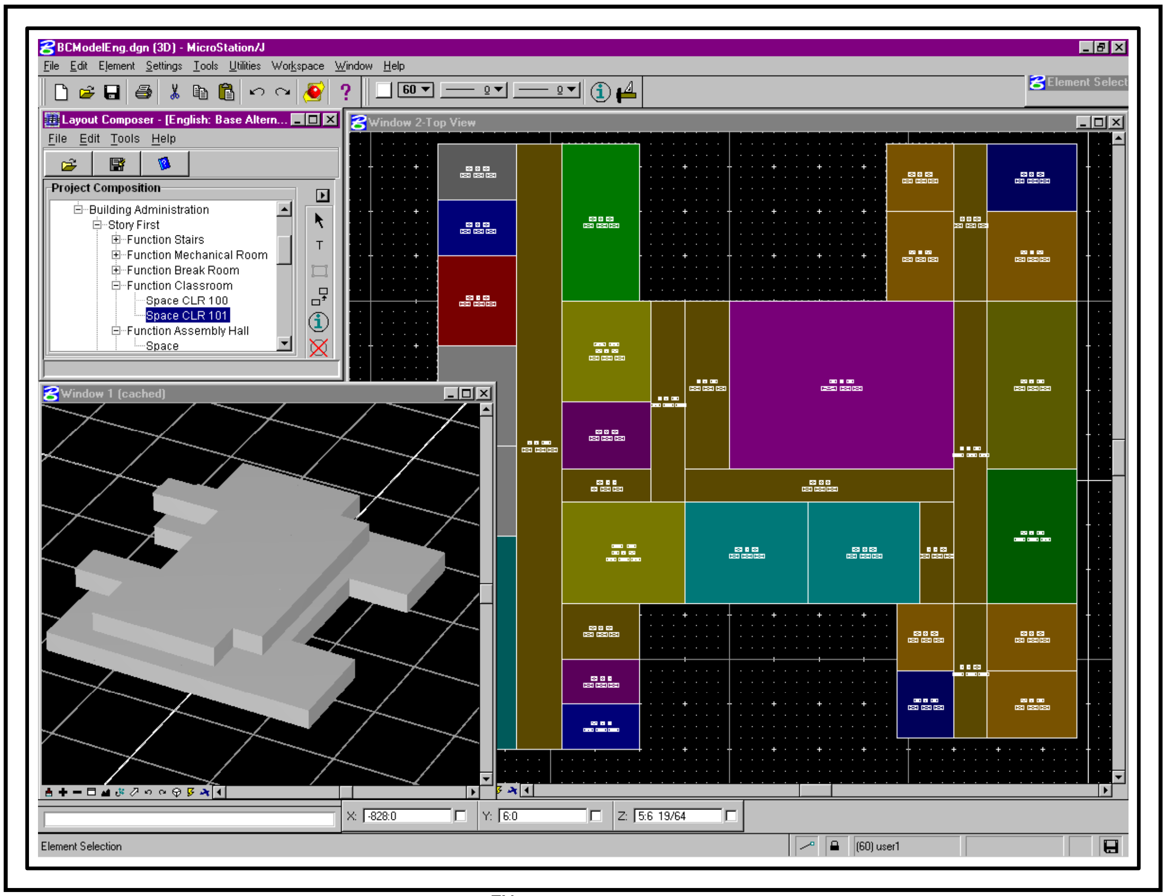

Figure 4. Layout Composer in Microstation/J.™

Layout Composer

Layout Composer (Figure 4) supports the creation of conceptual facility designs. Layout Composer works in conjunction with MicroStation TriForma™ or AutoCAD Architectural Desktop™ and uses the programmed area and criteria established in

Criteria Composer as a point of reference and comparison during design. In this phase, the architect would then determine how many stories are needed and what functions would work on which stories (blocking and stacking). Given chosen requirements such as building footprint, street appeal, adjacency, structure, building systems, form, and massing, the designer can explore conceptual alternatives to determine the best overall solution.

The spatial configurations that are created are not simply abstract geometry. The underlying model recognizes these spaces as offices, corridors, restrooms, or any other function in the customizable library, and therefore understands and provides reference to all of the criteria that applies for that particular function. For example, restrooms require an exhaust air system while offices do not. The default criteria associated with each space is sufficient to use Wizards to create a preliminary design and programming level cost estimate, along with other types of analysis. System selections can be made at this stage, but are not required.

Layout Composer assists in the design process by providing an environment that explicitly (and parametrically) supports the concepts of multiple stories, functions, and spaces. This simplifies the interface by allowing operations to occur on these elements rather than requiring an understanding of the native CAD platform commands. For example, to change the floor-to-floor height of all of the spaces on a particular story, one just needs to change the value on the story and all of the spaces comply, rather than selecting walls and stretching them as in a typical CAD environment. Also, deleting a story is as simple as deleting the item in the tree hierarchy interface as is commonly done on files on today's operating systems, rather than requiring an understanding of file referencing to other story drawings.

Another important concept and feature in Layout Composer is the ability to present the design differently based on the user's task and objective. For example, during design, a view named "Above / Current / Below" could be used to quickly see the spaces on the current story with the regular symbology, and all of the spaces on the stories below with a grayed line, and the spaces on the story above with a dotted line, as is a current convention in practice. This allows a quick assessment of the relation of forms on particular stories to other stories in a building. Other representations include a "Bubble Diagramming" view, which is useful for presenting conceptual relationships, and a "Color by Function" view, which provides visual feedback on functional groupings.

In addition, Layout Composer assists the designer by supporting the use of pre-designed solutions of configurations of one or more spaces. For example, if a particular building type typically uses one of four bathroom layouts, these can be stored and reused preventing the need to “reinvent the wheel” in subsequent designs.

Once a design proceeds past the Conceptual Design phase to the Design Development phase where system and component selections are no longer optional, Building Composer continues to provide value in several ways:

- Engineers can use Criteria Composer to reference and target the requirements associated with their discipline.
- Wizards are available to expedite the system selection process as well as other design tasks.
- The completed architectural program can be exported to a detailed cost-estimating tool as well as customizable reports.

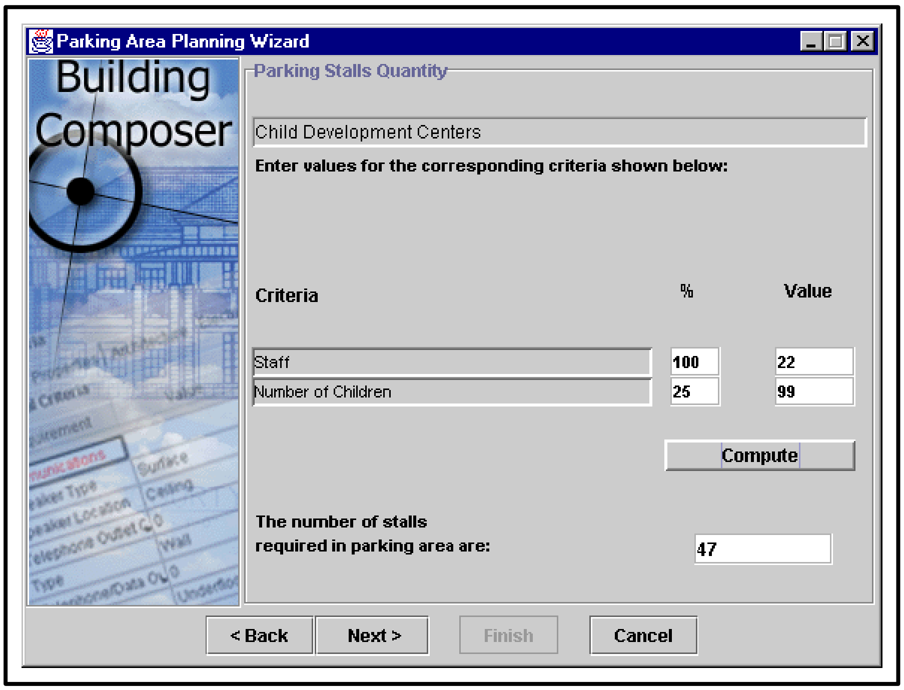

Figure 5. Example Wizard.

Wizards

Wizards are software components that operate on a discrete design task by taking criteria and user input in order to create or manipulate a building and criteria model rapidly, all according to generally recognized or organization specific practices. A Wizard extends Building Composer functionality and knows how to use the criteria data expressed in Criteria Composer to create or analyze something in a useful way. An example of a simple wizard might be one that determines the number of parking stalls required for a building with a particular building occupancy level, based on an individual organizations standard design criteria tables and algorithms (Figure 5).

Wizards assist the designer in ensuring that the design solution meets the design guide requirements, in ensuring that the customer's requirements are being satisfied, and in providing additional accuracy and speed over manual calculations. Wizards do not encode only one particular method and set of data, but rather provide flexibility for adapting to different design practices, commonly by building type. There are three different categories of Wizards that can help users in different ways:

1. Criteria Wizards are wizards that assist a user primarily in Criteria Composer by providing one or more worksheets consisting of questions and answers, selection options, and structured data entry (to name a few) from which an algorithm or calculation is performed to arrive at a value for a particular criteria. The parking allowance Wizard in the example above is a perfect example of a Criteria Wizard.
2. Model Generation Wizards are wizards that interact with commercial off the shelf software to generate model components and objects through parametric modeling formulas or manual specification. Examples of these would be a Duct Layout Wizard based on supply and exhaust airflow, a Lighting / Ceiling Grid Layout based on grid spacing, diffuser layouts, lighting algorithms and requirements (footcandle, lumens).
3. Of particular interest are model generation wizards that take an initial space layout of a building and then automate the generation of a building model consisting of walls, floors, ceilings, and roof objects. The building model here is based on the criteria established for each of the associated elements. For example, a particular function may specify a particular wall type and a building may specify a particular exterior wall type, from which the appropriate elements would be generated. At this point, Architectural Desktop or Triforma will be used to facilitate detailed design and construction document generation.

Analysis Wizards interact with third-party COTS analysis tools in addition to custom analysis tools written within Building Composer. Examples of third-party tools might include: energy analysis, security analysis, and force protection analysis. Analysis Wizards currently being considered for Building Composer are net to gross area calculation and preliminary egress analysis.

In summary, *Building Composer* is a suite of facility design tools that integrate client-specific criteria with a life-cycle facility model and commercial tools. Designers benefit from having criteria at hand and from having an a la carte toolbox of design and analysis wizards that automate tedious tasks, freeing designers, to a degree, to concentrate on higher-level design and use issues. Clients benefit from a

centrally managed set of criteria that is explicitly addressed in the design process, therefore **improving quality**, supporting design flexibility, and **reducing the time and cost** of facility acquisition.

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Point of Contact

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The "Greening" of Fort Bragg: Creative Reuse a New Construction Site

By Lynda S. Pfau, Environmental Resource Coordinator
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Environmental Compliance Branch
NEWS RELEASE For immediate release
FORT BRAGG, NC, 11 February 2002

Mulch and oil are mixed and stockpiled just outside of the construction area to be reused on the site at a later date.

Construction on Fort Bragg, North Carolina, is moving in a new direction. Rethink, reduce, reuse, and recycle are keywords in the new environmental culture evolving on Fort Bragg. By operating in a manner today that will enhance our ability to operate in the future, Fort Bragg continues to set the standard in environmental sustainability.

At the new Design/Build Combat Aviation Barracks Complex construction site located on Longstreet, Caddell Construction Company, Inc., of Montgomery, Alabama, is taking additional steps to help Fort Bragg meet one of ten strategic environmental goals – reducing landfill waste toward zero by 2025.

By converting unmarketable natural resources to usable materials such as mulch, landfill waste and energy consumption are reduced.

"If we have the ability to use it (land-clearing debris)," said Timothy Jackson, Project Manager for Caddell, "then why not use it? We try to utilize common sense on what's being developed from the job site."

Common sense has been used from the very beginning on the 70-acre site. Extra care was taken by the United States Army Corps of Engineers (USACE) in marking and removing only the trees necessary for construction rather than clear-cutting the site. Even then, the trees that had to be removed were not just hauled away to the landfill. USACE took the "greening" initiative one step further and called in Harvesting and Reforestation Company of Castle Hayne, N.C.

Bobby Smith, manager for Harvesting and Reforestation, brought in a tub grinder capable of handling trees up to 14' wide and 12' long. The 1,000-hp engine turns approximately 28 diamond-tipped teeth at 20,000 rpm to produce120-160 tons of mulch per hour.

Smith said the huge investment in the tub grinder was an investment in the environment as well as a necessity.

"Raleigh, Durham, and New Hanover are no-burn counties (in North Carolina)," Smith said. "So many counties are going in that direction. To keep it out of the landfills, we had to go to grinding."

"We make it usable for somebody," said John Melton, an employee with Harvesting and Reforestation. "It's all about recycling. The tub grinder is another recycling tool." Mulch from the downed trees has been stockpiled at the site for use in the future as ground cover.

William Squire, Solid Waste Manager at Fort Bragg's Public Works Business Center, (PWBC), estimates Harvesting and Reforestation has diverted more than 240 tons of land-clearing debris out of the Fort Bragg landfill with this initiative. Reducing the amount of waste going to the landfill is important beyond reaching the strategic goal. Over the last seven months, more than 50 percent of total solid waste disposed of on Fort Bragg was land-clearing debris.

According to Robert Ford, Project Engineer, USACE, Fort Bragg Area Office, additional mulch generated from one area of the construction site will be intermixed with soil and turned on a regular basis so that in three years the stockpile becomes fertile topsoil to be incorporated in to the final phases of the project.

After removal of the trees, Caddell Construction took further steps to reduce and reuse. Topsoil stripped from the site for grading and excavation purposes was also stockpiled for reuse at the same construction site. This practice cuts down on hauling requirements and unnecessary depletion of soil from Fort Bragg's Borrow Pit or purchase of new topsoil.

Jackson says doing construction in an environmentally sound manner is literally a win-win situation.

"This type of practice helps Caddell, helps with the storage situation and helps keep usable material out of the landfill," said Jackson. "It also helps the Corps of Engineers and the government as well."

Protected wetlands, covered by state and federal regulations, surround the construction site. Permits have been acquired and proper erosion control measures taken to protect the wetland areas by use of silt fencing, sediment ponds and diversion ditches.

Jackson said more rethink, reduce, reuse and recycle practices may develop on the construction site in the future.

"As a design-build project, further environmental practices may evolve as construction progresses," said Jackson.

Fort Bragg's Environmental Compliance Branch is aggressively working with the Construction Management Division and the Corps of Engineers to identify other design and construction initiatives that will not only preserve our resources but make good business sense as well. Many of these ideas will be incorporated in the "Installation Design Guide" (IDG) that is currently under revision. The IDG provides requirements and standards for all construction on Fort Bragg.

Christine G. Hull, Ph.D, Fort Bragg's Sustainability Planner, feels procedures employed for the Combat Aviation Barracks complex are just the beginning in the journey toward environmental sustainability.

"Environmentally sound procedures such as those used at the new complex ideally will be built in to future contracts," said Hull. "Everyone from designers to backhoe operators to carpenters will become an essential tool, even a stakeholder, in this program. Recycling and reuse will be the norm; expected. The implementation of sound environmental practices and sustainable design concepts, paired with the size of the installation's construction program and the significant number of upcoming projects, presents a golden opportunity for Fort Bragg to affect change at a much more rapid pace."

Consisting of three main phases, the Combat Aviation Barracks complex is scheduled for completion October 2004.

Mulch from the construction site has also been stockpiled at the landfill and is free of charge to installation organizations/agencies, as well as soldiers and their families.

Bobby Smith of Harvesting & Reforestation Company, loads the tub grinder to recycle timber debris into mulch.

Bobby Smith of Harvesting & Reforestation Company, loads the tub grinder to recycle timber debris into mulch.

Specifying Paint

By Al Beitelman

Paint has been around for thousands of years, but the way the federal government specifies paint has never undergone such radical changes as it has in the past decade. The most recent changes have been brought about by what has been termed "acquisition reform" driven by the Federal Acquisition Regulation (FAR). Essentially the FAR states that Federal Government agencies are supposed to specify products generically as much as possible. To this end, Army, Navy, General Services Administration (GSA), and most other agencies have been specifying paint by referencing the Master Painter Institute (MPI) specifications which tests paint to determine performance before the paint is put onto their "Detailed Performance" lists.

FAR Specifications

FAR places specifications in 3 categories in order of preference: 3rd preference is the traditional government federal or military specification (TT-P-xxx or MIL-P-xxxx). These specifications often describe paints in terms of specific amounts of ingredient materials. Manufacturers can formulate products to meet the requirements but the products are usually not available on the shelves of the local paint store. 2nd preference is a performance specification. Within the government these specifications could take the form of commercial item descriptions (CID) (A-A-xxx).

These documents are quite short and describe a paint in terms of specific performance requirements. In the development of a CID the government must verify that commercial products do exist which will meet the requirements. Since not all products will meet the requirements, testing must be performed to verify that any given product has the required performance. 1st preference is industry specifications. Obviously it is assumed that if industry has developed the specification, there must be industry products available which meet the requirements of the specification. Another benefit is the fact that the government does not have to bear the expense for developing and maintaining the specification. Within the past decade there has been an incentive for government agencies to show progress toward the greater use of specifications in a more preferred category.

The federal and military specifications will probably never completely go away for highly specialized coatings, but the specifications for the majority of the common paints were cancelled in favor of CID specifications in the mid 90's. This should have been a step in the right direction but unfortunately the commercial products were often not tested for CID compliance and the application of inferior products resulted in low performance.

MPI

The big change to industry specifications began with a meeting in late 2000 when Army, Navy, GSA, and others agreed in principle to convert guide specifications to reference industry specifications developed by the Master Painter Institute (MPI). MPI is a private company that has written its own specifications. The company tests off-the-shelf paint to its own specifications. Paints meeting these requirements are added to a WEB listing of approved products. At this time government agencies are only using the MPI "detailed performance" listed products.

All products on the various MPI detailed performance lists have been tested and found to meet specific performance requirements. There is also a sideline on these lists that identifies the level of volatile organic compounds (VOC) in the paint. By requiring an MPI listed product having a specific VOC category, an installation can control the emissions from the painting operation. MPI has only begun to add a second sideline to some of its products which gives the products an Environmentally Preferred Product (EPP) rating. This rating takes the VOC rating and gives additional points based on anticipated repaint interval (e.g. flat paints on walls, regardless of quality, get dirty easier so will need repainting sooner than paints with a higher gloss). These EPP values are very new but may eventually be accepted as justification for Green Building credits.

For the facility engineer, the use of MPI specifications has several benefits. Use of the specification rather than specific brand names assures competition as required by the FAR. Contracts can be developed using standardized guide specifications that are in the universally accepted CSI format. It also insures that the paint has already passed certain tests and will provide a given level of performance. The contractor can select any paint form the WEB listing and apply it without further testing. In most cases the contractor has a choice of suppliers including both national and regional manufacturers, thus allowing the selection of an easily obtained product having cost and application properties consistent with his operation. The MPI specifications are used in Army and Navy guide specifications UFGS 09900 and are available on the MPI WEB site, http://www.paintinfo.com/.

The U.S. Army Engineer Research and Development Center's Construction Engineering Research Laboratory (CERL) serves as the Paint Technology Center for the Corps of Engineers. For more information about any paint issue, please contact:

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Specifying Environmentally Friendly Paint

By Eric Johnson and Annette Stumpf

The materials used to construct and finish buildings have a substantial impact on the condition of our environment. Simply being "smarter" about how we specify products can lead to significant benefits in total building cost, maintainability, durability and indoor environmental quality. Conventional paints contain materials known commonly as volatile organic compounds (VOCs). These components, being airborne after application, are detrimental to indoor environmental quality, which in turn puts human health at risk. By simply selecting paint products that contain low VOC quantities, substantial air quality improvements can be made.

A Department of Defense (DoD) pilot project at the Aberdeen Proving Grounds (APG) – www.apg.army.mil/AP2G/PDF/paintstudy.pdf – concluded that low-VOC paints, on average, cost $1.76 less per gallon than standard, high-VOC paints. This difference constitutes large savings when bought in large quantities, as is common for the government. From a study conducted by Clean Air Counts:

APG saw immediate monthly savings amounting to $528 for the 300 or so gallons of paint they purchased. In addition, since the APG's paints were low in VOCs, excess did not need to be classified as hazardous waste (as high-VOC paints must be). The APG facility, as a result, saved an additional $25,000 in disposal costs during the course of a single year.

www.cleanaircounts.org/default.cfm?page=strategies&strategy=lowvocp_bd.

Clearly, the decision to use low-VOC paints is not only smart for the environment, but wise for the budget as well.

Specifying low-VOC paints is quickly becoming much simpler. At a meeting in late 2000, the Army, Navy, GSA, and others agreed in principle to convert guide specifications to reference industry specifications developed by the Master Painter Institute (MPI). The MPI website listing the approved products is currently located at www.paintinfo.com/mpi/approved/index.htm and is constantly being updated with new information. The MPI gives the products an Environmentally Preferred Product (EPP) rating. This rating takes into account the amount of VOCs (g/L) and gives additional points based on anticipated repaint interval (e.g. flat paint on walls, regardless of quality, gets dirty easier so will need repainting sooner than paints with a higher gloss). These EPP values are very new but may eventually be accepted as justification for SPiRiT credit 5.C4.2 (which currently requires that paints and coatings must meet or exceed the VOC and chemical component limits of Green Seal requirements – www.greenseal.org/standards/paints.htm.

It should be emphasized that lowering the amount of VOCs in paint results in changes in the overall composition of the paint, which may result in poorer ability to cover or less durability (both problems leading to the use of more paint, which may negate any loss in VOCs). For this reason, the MPI's rating system employs a 'bonus' system, where paints that go beyond the minimum VOC criteria, can be awarded higher marks. For information about this system, refer to the document posted at their website, listed here:
www.paintinfo.com/green/MPI_Notation_System.PDF.

For additional information, contact Annette L. Stumpf.

Fort Hood's Buildings are Turning "Green" (Straw Bale Building)

By Randy Doyle and Jeff Salmon

What are "Green" buildings? The term "green" in this case refers to environmentally responsible, productive, and healthy places to live and work. Executive Order 13123, Greening the Government Through Efficient Energy Management, directs the Federal Government to "significantly improve its energy management in order to save taxpayers dollars and reduce emissions that contribute to air pollution and global climate change". In order to promote energy efficiency, water conservation, the use of renewable energy products, and foster markets for emerging technologies, the EO has established six major goals with timelines:

- Reduce greenhouse gases attributed to facility use by 30 percent by 2010
- Reduce energy consumption per gross square foot of its facilities by 30 percent by 2005 and 35 percent by 2010
- Reduce energy consumption per square foot, per unit of production, by 20 percent by 2005 and 25 percent by 2010
- Expand the use of renewable energy
- Reduce the use of petroleum
- Reduce total energy use and associated greenhouse gases

In a May 2000 memorandum, the Army Chief of Staff for Installation Management (ACSIM) decreed that all future facilities would be designed and built according to sustainable principles. Sustainable Design and Development is the systemic consideration of current and future impacts of an activity, product, or decision on the environment, energy use, natural resources, economy, and quality of life. It is Army policy that the concept and principles of Sustainable Design and Development shall be incorporated into installation planning and infrastructure projects. ACSIM has asked the U.S. Army Corps of Engineers (USACE) to provide technical guidance to support this initiative. The guidance will ensure that Sustainable Design and Development is considered in Army installation planning decisions and infrastructure projects to the fullest extent possible, balanced with funding constraints and customer requirements.

In December 2000, FORSCOM hosted a Sustainability Conference, which was facilitated by the Rocky Mountain Institute. This conference instilled the mindset to put Fort Hood on a glide path to what we today call Sustainable Design Development (SSD). In April 2001, Austin's Green Building Program provided a presentation for the DPW Environmental Division consisting of an overview of green buildings and the USGBC LEED, Copyright © 2000 by U.S. Green Building Council. * This is where the "green" buildings come into the picture. So again, what are "green" buildings? Green Buildings incorporate design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants. Green building practices cover the following areas: sustainable site planning, safeguarding water and water efficiency, energy efficiency, conservation of materials and resources, and indoor environmental quality. The benefits of green design can be summarized into four categories: economic, health and safety, environmental, and community benefits. Economic benefits are experience in building operations, asset value, worker productivity, and the local economy. Also, occupants benefit from health and safety features, which are associated to risk management and its related economics. The local and global community benefits from protecting air and water quality, and overall biodiversity and ecosystem health. Finally, community and municipal benefits include a lessened demand for large-scale infrastructure such as landfills, water supply, storm water sewers, and their related development and operational costs; and decreased transportation development and maintenance burden and increased economic performance of mass transportation.

The Corps of Engineers Construction Engineering Research Laboratory (CERL) has developed a rating tool that will help identify and measure principles in projects. This tool is the "Sustainable Project Rating Tool" (SPiRiT). SPiRiT is based upon

LEED 2.0™. * The Sustainable Project Rating Tool will help designers of Army projects incorporate sustainable criteria, methods and materials into their projects to meet policy requirements.

In a May 2001 memorandum discussing Sustainable Project Rating Tool, the Army Assistant Chief of Staff for Installation Management directed "The initial Army goal is for all MACOM and installation projects to achieve a minimum SPiRiT Bronze sustainability rating." Understanding and applying the principles of SDD and using the SPiRiT rating process to improve day to day decisions and infrastructure projects is a gradual process. With experience and use, higher SPiRiT levels can be achieved.

In a June 2001 memorandum discussing Sustainable Design and Development (SDD), the Director of Military Programs, U.S. Army Corps of Engineers directed "Effective immediately, all of our new designs for military facilities shall strive to achieve SPiRiT Bronze level. When this level cannot be achieved, the District will inform MSC and HQUSACE. Districts are strongly encouraged to phase in SPiRiT into ongoing designs".

How does this effect Fort Hood? Fort Hood Directorate of Public Works (DPW), in concert with Steinbomer and Associates Architects, Bragg Landscape, Fire Protection Engineering, Beneco Enterprises, Jaster-Quintanilla & Associates, Way Consulting Engineers, HMG Engineering Associates, Austin Energy's Green Building Program and the Army Corps of Engineers, has partnered to design and build Fort Hood's first ever "green" facility. The Fort Hood Environmental Training Facility is scheduled to be the first of its kind to earn the COE's SPiRiT Platinum certification level. Platinum rating is the highest certification level achievable. This new 4000 square foot multi-purpose training facility will be located in the southwest part of main Fort Hood, near the current DPW headquarters. This quest required a dedicated team effort that capitalized on sustainable methods and practices while integrating new energy management technologies and methods.

Ground breaking for this one-a-kind facility is scheduled for early August. This facility will combine the latest in energy management technologies, while encompassing sustainable design concepts. Part of the floor is salvaged from a recently demolished bowling alley. The exterior walls will be made of straw bales, and the sand for the stucco will be ground bottles from Fort Hood's recycling center. The facility will utilize waterless urinals and low flow toilets to conserve water. In addition, rainwater collection will be used for a drip irrigation system. The landscaping design will utilize low maintenance, local vegetation while meeting

FORSCOM force protection requirements. For further energy management practices active daylighting will be used, along with motion sensors throughout the facility to turn lights off when not needed.

The orientation of the building is set to maximize the local weather patterns for cooling. The insulation factor of the straw bales, combined with the highly efficient Pella windows will provide a highly efficient structure. We anticipate a reduced need for conditioned air during the long hot Texas summers.

This quest has been a valuable educational experience for Fort Hood. We quickly came to the realization that we can't do it all. Decisions have to be made based upon desired sustainability versus budgetary restrictions. We utilized life cycle cost analysis to determine energy management methods that will give us the biggest bang for our buck, while earning enough points to achieve certification. We made the decision to use higher cost Pella windows for the higher efficiency value. Another important element is patterning the project to the area. Full length porches on the south, a breezeway to capture wind, double hung windows and a metal roof all help keep the building comfortable in the hot, humid climate of Central Texas. The use of low-emitting materials should be patterned after local or state regulatory requirements. The success of our project was a direct result of an energized team that had experience with sustainable designs and projects, and was motivated to think "outside" of the box. Scheduled for completion in fall 2002, this facility will be a showcase for sustainable design. This project is part of Fort Hood's ongoing efforts to "Green the Government".

For further information, see SPiRiT (Sustainable Project Rating Tool); USACE Memo directing the use of SPiRiT (01 June 01) (.pdf); and ACSIM Memo describing SPiRiT (04 May 01) (.pdf).

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Energy in a New Era of Army Installations

By Dale L. Herron

Introduction

Energy represents a critical asset to mission readiness, both today and as installations transform. A safe, reliable energy infrastructure and dependable, long-term energy supply will be paramount to the transformed installations' success in housing, training, and deploying the force. Future Combat Systems may demand new types of energy delivery or support strategies. Further, emerging force protection issues may mandate built-in security measures, both in energy supply and distribution systems and in facilities vulnerable to chemical, biological, and radiological (CBR) threats.

Energy research by the U.S. Army Engineer Research and Development Center (ERDC) will be used in the Fort Future modeling and simulation (M&S) process. Transformation of the Army's installations offers major opportunities to make these small "cities" future world-class examples of sustainable, reliable, and energy-efficient facilities.

Background

For the last quarter century, federal energy policy emphasized conservation. During this time, DOD has been challenged with increasingly stringent energy-reduction targets. The Army initiated aggressive programs to meet these requirements and is the only Service that has consistently met or exceeded all energy-reduction goals. More recent DOD energy strategy incorporates sustainable energy design considerations to address life-cycle costs of installation energy investments. Initiatives like privatization of utilities also have taken on increased emphasis. DOD's energy focus is again evolving to now encompass energy security. The following major events triggered this shift of emphasis:

- Energy shortages in the United States during the 2001 heating season and in California that summer caused rolling blackouts and large short-term energy price increases.

- The tragic events of September 11, 2001, and the follow-on anthrax attacks demonstrated both the fragility of the Nation's infrastructure and its impact on personal safety.
- The bankruptcy of Enron, one of the largest energy companies in the world, raised questions about the long-term availability and viability of the nation's energy supplies.

Energy security will clearly be a key aspect of the Nation's energy focus for the foreseeable future. Energy conservation and sustainable design will also continue to be important. Thus, the collective challenge now is to address the need for a safe and reliable energy infrastructure and a dependable, long-term energy supply without losing the successes achieved for energy conservation and sustainable design.

Future Installation Strategies

As the Army installations of today transform, the use of safe, dependable, and environmentally sound energy technology is essential. Army soldiers and their families must live and work in facilities where embedded energy technology maximizes personal and environmental safety and relies on secure sources of electricity, heating, and cooling energy. Realizing this ambitious energy goal is vital to achieving a sustainable, high quality of life for soldiers.

The first step in achieving this goal is to develop an integrated and strategic planning philosophy for how energy resources will be managed at future installations. Integrated strategic energy planning will require looking beyond the building level, beyond the installation fence, and even beyond the surrounding region to a national, if not global, perspective. Good planning will forecast which energy technologies and strategies will be best integrated into a diversified portfolio of energy supply options. Issues that must be considered include reliability, security, and sustainability from an environmental standpoint. In addition, energy conservation, energy use reduction goals, utility privatization, and utility deregulation will factor into the decisionmaking process. Once policies and plans are established, they will need to become part of the business processes for the Army's new Transformation of Installation Management organization.

Second, future Army installations and individual facilities must be sustainable. Army documents define sustainability as the "design, construction, operation and reuse/removal of the built environment--infrastructure as well as buildings--in an environmentally and energy efficient manner ... meeting the needs of today without compromising the ability of future generations to meet their needs."

Next, secure sources for electricity, heating, and cooling must be identified. An emerging, promising trend for realizing our future electrical energy needs is a shift from purchasing electricity generated by large, company-owned, central-generation plants to small, high-efficiency power sources located at the point of consumption. Distributed electrical energy systems can include solar photovoltaics, fuel cells, gas-fired microturbines, and wind turbines. These systems offer the security and flexibility of onsite electricity generation and are extremely environmentally sustainable.

Finally, the technologies used for heating, cooling, and lighting individual Army buildings must maximize human security, comfort, and productivity while minimizing energy consumption and cost. Promising new heating, ventilation, and air conditioning (HVAC); boiler; chiller; lighting; and direct digital control (DDC) technologies are continually emerging. Future Army facilities must take advantage of these technologies, but only if they can be installed and commissioned to operate correctly when new and throughout the facility life cycle. The best energy technology is of no value if it cannot be properly installed, operated, and maintained.

Some of ERDC's energy research relevant to installation transformation is described below.

Strategic Energy Planning

ERDC is developing a coordinated methodology for installation strategic energy planning (ISEP). The methodology will evaluate short- and long-term utility and energy issues while integrating energy demand and supply issues. When applied to an installation, the ISEP process will result in an investment strategy mixing privatization, utility-company use, third-party initiatives, and programmatic funding vehicles to achieve the desired energy goals. This type of energy investment plan will be integrated with other funding strategies for transforming installations. More information is available at http://www.cecer.army.mil/SEP/index.htm.

SPiRiT and Other Tools

ERDC has developed a rating tool that will identify and measure sustainable principles during construction project planning. The Sustainable Project Rating

Tool (SPiRiT) is designed to be an easily understood Microsoft Excel worksheet that will allow self-scoring by building delivery teams either during the charrette process or by an independent panel. The U.S. Army Corps of Engineers requires its designers to use SPiRiT and strive to achieve a "bronze" rating for all future projects. The Army also may require sustainable development on a DD Form 1391, which is used to request all military construction projects within DOD. To view the current version of SPiRiT, go to: http://www.usace.army.mil/inet/usace-docs/eng-tech-ltrs/etl1110-3-491/a-c.pdf.

Other ERDC-developed tools may be linked to the suite of M&S tools for Fort Future. They include the Renewables and Energy Efficient Planning Program for energy and water analysis and EnergyPlus, which is the Department of Energy's new tool incorporating ERDC's Building Loads Analysis and System Thermodynamics Program.

DOD Fuel Cell Program

Stationary fuel cells, which allow onsite electricity production, could give future installations a reliable power source for critical facilities. They are also nonpolluting. ERDC manages the DOD Phosphoric Acid Fuel Cell (PAFC) Demonstration Program, which has the following objectives:

- Demonstrate fuel cell capabilities in real-world situations,
- Stimulate growth and economies of scale in the fuel cell industry, and
- Determine the role of fuel cells in DOD's long-term energy strategy.

PAFCs were installed at 30 U.S. military bases between 1994 and 1997, making this the largest demonstration of PAFC power plants in the United States. A follow-on program, the Residential Demonstration Program, is targeted at installing 21 small Proton Exchange Membrane fuel cells at DOD sites.

A major success story in fuel cells research was the installation of five fuel cells, connected in parallel to produce 1 megawatt of electricity, which are now the primary source of power for the U.S Postal Service Mail Processing Center in Anchorage, AK. It is the Nation's largest assured-power commercial fuel cell system to date and, for the first time, a fuel cell system is part of an electric utility's grid. This type of application has important implications for providing an uninterrupted power supply at future installations. More information about the DOD Fuel Cell Program is located at http://www.dodfuelcell.com.

Interoperable DDC Controls

Emerging "smart" HVAC controls could play an important role in ensuring safe operation and efficient energy use in existing and future facilities. HVAC and other energy systems in modern buildings are typically controlled by state-of-the-art DDCs, which allow building energy systems to be operated in a safe, efficient manner while maximizing occupant comfort and productivity. DDC systems can also be networked together so that multiple buildings can be controlled from a central location, but until recently all the networked systems had to be from the same manufacturer.

Recent developments in the controls industry may have made it possible to interconnect multivendor systems. This is important to the Army because the government's competitive procurement process has, over the years, meant that Army individual DDC systems were purchased from many different manufacturers. Effectively connecting multivendor DDC systems will enable Army installation energy managers to fully implement installation-wide energy security and conservation strategies. An initial demonstration of an interconnected multivendor system is underway at Fort Hood, TX. More information about this project can be obtained at http://www.cecer.army.mil/td/tips/docs/finney_fthood.pdf.

HVAC CBR Protection

The recent anthrax attacks at the Hart Senate Office Building and other facilities have demonstrated that HVAC systems can play an important role in minimizing the impact of a CBR attack. As part of the Fort Future effort, ERDC is now developing an HVAC CBR M&S capability to help installation planners and facility designers optimize the level of protection that a facility's HVAC system can provide against a CBR attack. ERDC is also working with individuals associated with the Defense Advanced Research Projects Agency's Immune Buildings Program to develop HVAC hardware with improved CBR protection and improved design methods for implementing CBR protection in facilities.

Conclusion

As the Army transforms its existing installations to support the Interim and Objective forces, energy is a critical consideration. The energy technology associated with the facilities at these new installations must provide soldiers and their families with first-class facilities that maximize safety, comfort, and productivity at minimal energy cost. The shift in the Nation's energy focus from conservation to security, the emerging technology from the energy industry, and the research results from ERDC and other organizations offer the Army tremendous opportunities to make these future installations world-class examples of sustainable, reliable, and secure facilities.

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Fort Future: Modeling Tomorrow's Army Installations

By Dr. Michael P. Case

Introduction

Research in a program called "Fort Future" will produce tools critical to the Army's ability to transform its installations in the timeframe required to support our emerging forces. Much like field commanders gain a superior advantage by visualizing the battlespace, installation planners will make strategic decisions by "seeing" results of many different scenarios.

Fort Future research and development is being conducted by the U.S. Army Engineer Research and Development Center (ERDC) in support of the Office of the Assistant Chief of Staff for Installation Management (OACSIM). Fort Future will create a "system-of-systems" that unites existing and new computer models to form a virtual installation. Building on the currently available and planned Standard Army Management Information System (STAMIS) that provides a snapshot of the present, Fort Future will use modeling and simulation (M&S) to help decisionmakers explore alternatives in the complex issue of preparing installations to support future forces.

Background

Simulation and Modeling for Acquisition, Requirements and Training (SMART) is an important part of the Army's strategy in procuring Future Combat Systems (FCS). The SMART strategy uses simulation to evaluate the performance of candidate system concepts before committing substantial resources to systems development. Transforming the Army's installations represents a huge national investment for which appropriate choices must also be made. Fort Future follows the SMART approach in allowing installation planners to model and simulate proposed changes to the infrastructure and environment and evaluate their effectiveness.

The initial 5-year Fort Future effort was approved as an Army science and technology objective beginning in FY02. Several M&S tools are under development, with other existing systems being integrated into a suite of Web-based tools.

Objectives

The key objective of Fort Future is to develop a capability to model, simulate, assess, and optimize installation capability to support the Objective Force. Users of Fort Future, at the installation, regional, or national level, will be able to set up planning scenarios, conduct dynamic analysis over a period of up to 30 years, and compare scenario results. Fort Future will allow decisionmakers to do the following:

- Provide an integrated sustainability planning capability to support mission essential task list (METL) analysis, master planning, and natural and cultural resource planning.
- Simulate and optimize planning for force projection. Metrics will focus on risk-based evaluation of an installation's ability to project forces over time.
- Simulate urban and regional growth around installations as a foundation for analysis of mission sustainability. Factors to be evaluated include encroachment, noise, traffic congestion, habitat, and threatened and endangered species.
- Manage facility requirements to rapidly generate, visualize, and analyze facilities for the Objective Force. The analysis will include force protection and sustainability issues.

Approach

Fort Future will integrate existing computer models where feasible and create new modules where necessary. The goal is to present results of M&S as clearly as possible, making maximum effective use of advanced visualization to enhance understanding of a decision's implications. Fort Future will use the following fundamental process:

- Create scenarios,
- Conduct analysis using selected computer models,
- Compare and contrast results, and
- Optimize.

The Foundation

The baseline for Fort Future analysis will be created using data from STAMIS and other publicly available repositories. For example, the U.S. Army Training and Doctrine Command (TRADOC) Corporate Database and OACSIM's Geospatial Information System Repository (GIS-R) (see the accompanying article on Page 22 of this issue) pull data from the Installation Status Report, the Integrated Facilities System, and Geographic Information System (GIS) maps into a common data store. When properly updated during the normal course of business, such repositories serve as the best source of data about the current status of an installation. Therefore, access to this information will be an essential element of Fort Future. The currently available TRADOC Corporate Database will be used as an initial module.

Achieving interoperability between systems can be a daunting task. Fort Future will take advantage of Common Delivery Framework (CDF), which is being developed by the U.S. Army Corps of Engineers (USACE) to support interoperability and reuse of information technology capabilities in all USACE business areas. CDF uses open standards, published by the World Wide Web Consortium, to make software decision tools, models, and guidance available online.

Access to initial Fort Future capabilities will be provided through the Fort Future Workbench, a Web-served application. Through the workbench, installations, Transformation of Installation Management regional centers, and all "front office" elements will be able to set up private M&S workspaces, with a shared lessons-learned capability based on USACE's corporate lessons-learned module. Ultimately, Fort Future services are targeted for portals such as Army Knowledge Online, an

OACSIM portal, or the Defense Environmental Network and Information eXchange (DENIX).

Sustainable Planning

Creating alternative scenarios is the key initiating process for Fort Future. Based on results of the installation transformation game, the sustainable planning module of Fort Future will be a planning tool for installations. Using a METL created from a template, the module will guide users through a process to create a tree structure using elements pulled from master plans and integrated natural and cultural resource management plans. For example, users will be able to designate proposed land-use policies on a GIS interface, which will be captured as a data structure in the tree. Using this process, users will create alternative scenarios to be modeled.

Planning Markup Language (PML) will be an integral part of the sustainable planning module. Using an XML [eXtensible Markup Language] format based on open standards, PML will provide a downloadable description of initial conditions and planned policies that can be read by M&S programs. Standardization efforts will build on industry relationships already formed through the DOD CADD[computer-aided drafting and design]/GIS Technology Center.

Force Projection

Objective Force deployment will be modeled using queued network methods and commercial software commonly used in industrial engineering. Fort Future users will be able to download parametric model templates from a Web site and run simulations locally. By correlating stations and resources with facilities on an installation GIS, parameters such as travel time and number of staging areas can be automatically populated.

Initial models have already been constructed using Interim Brigade Combat Team (IBCT) examples obtained from the Military Traffic Management Command-Transportation Engineering Agency and Fort Lewis, WA. Research will be conducted to determine the degree of correlation between facility condition, planned maintenance, and risk to power-projection capability. Using these models, planners will be able to quantify criticality of facilities and justify resources.

Working with the Force Projection Battle Lab Support Element at Fort Eustis, VA, installation planners will evaluate the force projection module as the installation component within the suite of models used for deployment analysis. An integrated projection simulation capability consisting of multiple installations is also planned.

Training And Sustainability

Army transformation poses serious challenges to training on today's installations. Projections indicate that weapons will shoot farther and training will take significantly more space, with virtual and live training being conducted concurrently. The sustainable training module of Fort Future will be designed to help decisionmakers identify risk factors promptly so that steps can be taken to avoid conditions that might limit training. For example, if installation planners could identify potential areas of high growth and complaints about noise, they could work with local planning boards to establish buffer zones of compatible use.

To predict growth, ERDC is modeling urban and regional dynamics in a system called the Military Land-use Evaluation and Impact Model (mLEAM). The system runs on massively parallel supercomputers that make enormously complex calculations available to users within minutes rather than hours.

The goal of Fort Future is to bring mLEAM to the desktop through a Web interface so that it will be available to installation and regional planners. In the first prototype, planners will be able to run mLEAM at Fort Benning, GA, on a secure Web client, and then overlay noise contours for IBCT weapons. Other factors such as threatened and endangered species, traffic congestion, energy use, water consumption, and encroachment frequency will be added, as will a multi-installation analysis capability.

Facility Modeling

Before Objective Force brigades can be deployed, installations must conduct analyses to determine their facility requirements. The difficulty of this task is compounded by the fluid state of information about the FCS and the long lead time (5 to 7 years for large facilities) built into the Military Construction, Army (MCA) and National Environmental Policy Act (NEPA) processes. Installations designated for IBCTs have been overloaded with requirements to produce large numbers of DD Form 1391 planning documents, used to request all military construction projects within DOD, in a very short time. Under the unit set fielding process, systems cannot be fielded until supporting facilities are in place, adding even more pressure on the MCA process.

A Fort Future component called Building Composer will shorten the time required to acquire facilities while ensuring that Objective Force and FCS requirements are met. Building Composer tracks facility requirements, supports planning and design processes, and supports associated analyses. Users will be able to download libraries of requirements from the Fort Future Web site, construct a building program, visualize the building design for sustainability using the Sustainable Project Rating Tool (SPiRiT), obtain a cost estimate, complete a DD Form 1391 planning document, and produce a design-build request for proposal.

The Building Composer team is testing the system by building a requirements library for IBCT maintenance facilities based on lessons learned from Fort Lewis. Military Operations on Urbanized Terrain (MOUT) facility requirements will also be added. An advanced immersive visualization capability is being developed using a facility called the CAVE [Core Automated Virtual Environment] at the University of Illinois. The goal is to test the workability of proposed maintenance facilities using computer models of FCS components. Using this feature, a designer will be able to virtually pull a vehicle into a maintenance bay and visually check factors such as worker and crane access.

Force Protection

The USACE anti-terrorist (AT) planning software (AT Planner) is a primary tool in Fort Future, with events of September 11, 2001, increasing its importance. Fort Future will initially address blast effects and chemical, biological, and radiological (CBR) vulnerability. An initial force protection module will provide a capability to download site and building information to Blast Effects Estimation Model or AT Planner, simplifying the process of setting up a simulation. To protect against CBR threats, new requirements will be incorporated into Building Composer and eventually feed the Defense Advanced Research Projects Agency's Immune Buildings Program. Potential modules for physical security are also being explored.

Conclusion

Fort Future has charted an ambitious course toward providing an installation simulation-based acquisition capability in support of Army transformation. Using an incremental delivery strategy, program planners will rapidly put systems in the hands of users and validate and refine them through the new installation battle lab. Beginning with computer models for single installations, these system-of-systems will evolve to allow multi-installation analysis in support of regional and national goals. Ultimately, Fort Future will support the proposed installation battle lab and sustainable installation planning exercises in ensuring continued mission support in the 21st century.

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Satisfying Sustainability and Historic Building Mandates

By Julie Webster

Authorities

- National Historic Preservation Act of 1966, As Amended (NHPA)
- Executive Order 13123, *Greening the Government Through Efficient Energy Management* (03 June 1999)
- Executive Order 12873, *Federal Acquisition, Recycling, and Waste Prevention* (06 August 1993)

The NHPA says: "Prior to acquiring, constructing, or leasing buildings for purposes of carrying out agency responsibilities, each Federal agency shall use, to the maximum extent feasible, historic properties available to the agency in accordance with Executive Order No. 13006 (May 21, 1996)." This statement is consistent with sustainable design principles now being mandated by Engineer Technical Letter 1110-3-491. By using our existing historic buildings, we are consuming less raw material, generating less waste, reducing the need for additional infrastructure, freeing up land assets for other priority uses, and conserving energy and dollars.

Aging military buildings were often conceived with thoughtful consideration for orientation and siting. They optimize their site's natural features, thus maximizing free site energy such as solar and wind attributes. This, coupled with a historically appropriate landscape plan, can contribute to the overall energy efficiency of a site and its buildings by providing passive solar energy functions such as sun shading and wind breaks. A general rule is to shade at least 30% of the site's non-roof, heat absorbing, impervious surfaces. Native or adapted plant material is preferred since it will thrive under existing conditions without the need for additional water resources.

Historic buildings are also endowed with passive aspects of their original design that provide significant opportunities for energy conservation and efficiency to reduce environmental impacts and life cycle costs. Such features as cupolas, monitors, skylights, sunrooms, porches, high ceiling heights with ceiling fans, as well as operable windows, shutters, blinds, shades, awnings, transoms, and vents, can indirectly facilitate energy conservation. Many historic buildings were designed for daylighting with tall windows and transoms for emitting light into interior spaces. Maintaining and restoring these features satisfy goals of both sustainability and historic preservation. Original lofty ceiling heights encourage natural convection and enhance stratification that is beneficial in summer months as hot air rises. Ceiling fans can redirect hot air back to floor level in winter months.

Appropriate use of exterior colors and materials can improve the thermal response of a building and reduce heat island affects. If historic paint colors and finishes were based on site and climatic conditions that persist today, returning to those same colors and finishes can reduce energy demands. Light colors reflect more of the sun's heat, keeping walls cooler and, conversely, darker colors absorb more of the sun's heat. Thus, darker colors are generally selected in northern or colder climates and lighter colors in southern or warmer climates. Regardless, color and material choices should be historically compatible.

One should not overlook opportunities to include passive aspects of historic buildings (noted above) in new construction, especially in historic districts. The use of appropriate refurbished or salvaged materials from demolished buildings in new construction should be encouraged as well. The result can be a new sustainable building that is compatible with its historic setting.

Many are under the misconception that modification and expansion of historic buildings is strictly prohibited. While this is not true, the Secretary of the Interior's Standards for the Treatment of Historic Properties do state that: "Because such expansion has the capability to radically change the historic appearance, an exterior addition should be considered only after it has been determined that the new use cannot be successfully met by altering non-character-defining interior spaces." For this reason, one should locate exterior additions to the rear, on inconspicuous sides, or on non-character-defining elevations of a historic building. Consistent with general good architectural design principles, their size, massing, materials, etc.

should be compatible with the historic building. Any rooftop additions, such as solar collectors and photovoltaic cells, should be set back from the wall plane to be as inconspicuous as possible when viewed from the street. Site feature additions, such as parking, loading docks, or ramps, should be visually compatible or as unobtrusive as possible. Existing site features can often be upgraded to be more sustainable too. For example, consider preserving an entire historic light standard by retrofitting the fixture with a more efficient lamp and ballast system.

Finally, most installation personnel are familiar with the hazardous material concerns associated with older buildings. Lead-based paint, asbestos, and PCBs are the most common offenders. The most sustainable and historically sensitive method of dealing with such hazards is to encapsulate (or some other less invasive technique) for a "lead-safe" rather than "lead-free" building. This prevents pollution and keeps historical aspects of the building intact. Only when such action is deemed inadequate should one go to the trouble and expense to remove toxic building materials.

Links

For examples of sustainable historic building features in a tropical climate, visit the online report entitled "Historical and Architectural Documentation Reports for Albrook Air Force Station and Howard Air Force Base, Former Panama Canal Zone, Republic of Panama." The full report is online at the Legacy website: https://osiris.cso.uiuc.edu/denix/Public/ES-Programs/Conservation/Legacy/DocReps/hadr1.html

The specific section of interest is at: https://osiris.cso.uiuc.edu/denix/Public/ES-Programs/Conservation/Legacy/DocReps/hadr4.html#BSF

For further information, see ETL 1110-3-491 Engineering and Design - Sustainable Design for Military Facilities.

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"My boss told me to build it GREEN … What do I do now?"
A guide created by the USACE CERL Sustainable Design and Development Team

By Eric Johnson and Annette Stumpf
1 July 2002

Introduction

The results are in: the world is growing faster than resources can keep up, and the building industry has the largest potential impact on changing that fact. "Sustainable Design and Development" (SDD) is grounded in the idea that modern design and construction professionals must strive to meet the needs of the present without compromising the quality of life for future generations. Naturally, this seems like an overwhelming task, with so many possible solutions to consider at one time.

It must be emphasized that the only possible way to achieve a truly efficient, smart, sustainable, economically feasible solution is to embrace SDD as a holistic process. It must follow the building's life cycle from conceptualization, through design, construction, occupancy, and even recycling (reuse, remodeling, or deconstruction). All parties involved in this process must be made aware of all decisions and must also be challenged to provide innovative solutions to age-old problems. Moreover, designers, consultants, and contractors alike must agree from the outset to remain open to proposals and new ideas from all team members. Finally, participants must be educated in the methods of sustainable design, yet this is often difficult given the busy schedules within this industry. For that reason, a brief summary of the best approach to sustainable design is presented here.

Process and Methods

The sustainable design process can be explained in a simple, step-by-step process:

1. Organize Design Team
2. Conduct Charrette and Set Goals
3. Optimize Design
4. Create Documentation
5. Bid and Construct
6. Commission
7. Operate and Maintain
8. Recycle

While most steps in this process seem quite normal, further investigation will demonstrate that there are subtle changes to the "standard operating procedure" which must occur if the project is to become truly sustainable.

Step 1: Organize Design Team

The most vital component of a sustainable design is an educated, progressively minded team of individuals. All members of the team must be ready and willing to create the best solution, as well as be prepared to try new things along the way. The team should appear similar to the list found for a Form DD-1391 Planning Charrette, and therefore comprise:

- MACOM Representative
  - USACE Major Subordinate Command (MSC) Representative
  - Installation Representatives
  - User/Customer
  - Master Planner

  - Director of Public Works (DPW)
  - Director of Housing
  - Director of Community Activities
  - Director of Information Management (DOIM)
  - Provost Marshal
  - Force Protection Officer
  - Environmental Officer
  - Fire Marshal
  - Safety Officer
  - DPW staff to represent all utilities, base operations and engineering
- USACE District
  - Architect (A/E)
  - Project Manager (PM)
  - Sustainable Design Expert
  - Landscape Architect
  - Mechanical Engineer
  - Civil Engineer
  - Electrical Engineer
  - Cost Engineer
  - Value Engineer
  - Environmental Engineer
  - Economist
  - Geologist
  - Hydrologist

The Project Manager and Architect play especially important roles in guiding this process. It is essential to select an Architect/Engineer with previous sustainable design experience. An example Commerce Business Daily (CBD) Announcement illustrating inclusion of Sustainable design experience is available at www.cecer.army.mil/SustDesign/CEMP.doc. Engineers must no longer be viewed as "consultants" who are only to be brought into the project when needed. For example, if a Mechanical Engineer (ME) has a new, innovative Heating, Ventilation and Air Conditioning (HVAC) solution that would save the customer 50% on their yearly energy bill, but needs to be given a special allocation of space for mechanical services and components, that must be brought into the project as early as possible. Every party must follow the project through each of the major stages. In addition, this method of design encourages the recent push toward the Design/Build development process, as the contractor can then be included at the beginning of the project, rather than at the end of a standard Design-Bid-Build process. Contractors can help architects find out how well products perform, how long they last, how "buildable" a solution really is, and how much new construction techniques may cost – an invaluable resource.

Step 2: Conduct Charrette and Set Goals

After naming team members, they must be given an arena to voice their concerns and ideas, and also be educated on sustainable practices and new techniques. The charrette process is perfect for engaging all parties in a single, efficient, all-encompassing planning meeting. Members must come to the charrette with a certain degree of preparedness. However, it is not encouraged to have any real "concept" or "design" for the building at this early stage. Rather, suggestions will be made from all sides, and a design will develop from the synergy of these ideas. While this may sound overly complex and idealistic, when the process is approached with an open mind and a desire to succeed in creating the most sustainable project possible, the end results have shown great success.

The Sustainable Project Rating Tool (SPiRiT) can be used as a preliminary checklist during the charrette process. Each SPiRiT credit should be evaluated and given a "Y", "N", or "Maybe" based on whether each item can be incorporated, or if it must be considered later. In certain circumstances, some SPiRiT credits will be unachievable (Brownfield Redevelopment, for example) and would therefore be listed as "N/A". Most importantly, the minimum SPiRiT level for the project can be decided upon (Bronze is the established minimum, as per ETL 1110-3-491). It should be made clear that SPiRiT was never created with the intention of focusing on point totals and minimum requirements. Designers should endeavor to create the most sustainable building/installation and let SPiRiT be the "yardstick" with which comparisons between projects can be made. There should never be a reason to forego a sustainable solution simply because it is not rewarded an additional SPiRiT credit or a higher overall rating.

The most important outcome of the charrette process is the definition of goals for the project, and SPiRiT can be used to frame this process. These goals will deal with subjects ranging from cost limitations, to material quality minimums and standards, to minimum and maximum lighting levels, to daylighting requirements, to recycled content, and many others. Once these goals are set, they must be recorded in a Statement of Design Intent. This ensures that the sustainable practices and subsequent design solutions will be carried out with the closest possible adherence to the original intent. This document need not be overly detailed, however, it must be complete enough to describe all key points of the design in order for it to be truly effective.

Step 3: Design and Optimize

Once the goals are set, each party involved in creating the building and its systems must set out to create the best solution. In terms of optimizing the design, the Architect/Engineer (A/E) must focus on efficient space planning, future space uses, sustainable materials, minimization of the building footprint, siting and orientation, daylighting, passive heating, passive cooling, indoor environmental quality, users' needs, and others. The ME must work with the A/E to create the best HVAC system, as well as provide input into the building's overall shape and orientation to take maximum advantage of the natural environment. Likewise, the Electrical Engineer (EE) should strive to devise the best electrical layout and most efficient lighting plan. These are just a few examples of the team-oriented thought processes each player in the sustainable design process must consider. (See suggested SPiRiT team responsibilities by discipline, at www.cecer.army.mil/SustDesign/DivisionsAndRoles_v2.xls.)

Optimization of the design and of building systems must be analyzed through the use of life-cycle costs. Previously, importance has been placed on keeping first-costs as low as possible, without considering lifecycle impacts of durability, maintainability, or most importantly, impact on the environment. By optimizing every possible part of the design, the end result will be an efficient building that is a pleasant workplace, which won't quickly become obsolete or fall into disrepair before its expected lifespan. It should be noted that sustainable design does not imply low-end, boring, bland design. Rather, sustainable designs should strive for just the opposite. They should be seen as cutting edge buildings, setting the example for others to follow. Indoor environmental quality (IEQ) is as much a product of low-emitting materials and proper lighting as it is a product of well-designed space that incorporates timeless design language and high-quality, long-lasting materials.

CERL has created a tool to assist project teams by streamlining the construction design review process and ensuring that a sustainability review is conducted. The program, Design Review and Checking System (DrChecks), is a web-based tool that automates construction design reviews through real-time interaction and easy, accurate tracking. Reviewers, designers, and project stakeholders can make suggestions during the design process to improve the sustainability, constructability, operability, and long-term usefulness of the facility. Reviewers can create review comments or select from existing comments, which will then be associated with the project. DrChecks helps review comment authors and designers to reach agreement on the resolution of each suggested improvement. Current DrChecks users can use the "quick pick" feature to search on "(SPiRiTcheck)" to retrieve and apply standard comments for each SPiRiT credit or requirement to the project. Once applicable comments have been selected, they can be edited as needed. A TechNote describing how to use these standard SPiRiT comments will be posted on www.projnet.org under the FAQs (Frequently Asked Questions) in the near future.

Once an acceptable level of refinement and completion has been reached and the design is ready for bid/construction, the SPiRiT self-rating process can be conducted. The parties responsible for the project must collaborate and agree or disagree on the adequacy of each solution provided for a particular credit. Some find a simple spreadsheet is helpful in tallying or averaging the credits to provide the most accurate/democratic result. There is no need for additional documentation to justify credits, although a short summary describing the SPiRiT rating should be included in the project file. Note that the SPiRiT credits concerned with construction waste management/commissioning/IEQ testing/etc. should be evaluated upon completion of the project.

Step 4: Create Documentation

The building's construction documents should clearly record the sustainable design intent established during the charrette and other decisions made during design development. The bidders (in a standard design-bid-build process) must have full knowledge of the design intent if accurate bids and a smooth construction process are desired. Care must be taken to provide specifications that clearly state the performance criteria of materials. Also, by placing emphasis on "integrated building systems," the drawings and specifications should work together to explain how these systems are being used, and how they should be constructed. Ideally, bidders would be well educated in the area of sustainability, but in the event that they are not, the documentation package should provide them with adequate knowledge of the driving forces behind the project.

Step 5: Bid and Construct

The project team must be prepared to educate the bidder/contractor who wins the contract. This education process will become smoother with respect to the amount of clarity and information contained within the bid package. A clear Statement of Design Intent will help the contractor understand how a "sustainable" project is different from their typical projects.

Contractors should be made aware that on-site waste management techniques, efficient materials use, and materials recycling will save them money, and could be given an incentive package based on the demonstration of best management practices and on-site recycling and waste management techniques. Also, the contractor must know that with a sustainable building project, special attention must be paid to the maintenance, health, and minimal disturbance of the existing site and its surroundings. Maintaining the environment and habitat during the construction process should be a vital part of the Statement of Design Intent.

Step 6: Commission

Building commissioning is an important step in assuring the owner/operator that the building has been completed in accordance to the Statement of Design Intent. "Commissioning" is essentially a process of testing and demonstrating that all systems, materials, and equipment are installed properly, operating properly and are of the quality specified. Too frequently buildings (even new ones) are constructed with unspecified mechanical system components, or incorrect lighting, or systems which aren't functioning properly. In a commissioned building, all mechanical, plumbing, electrical, and other systems such as sprinklers, elevators, audio/visual, and control devices will be tested for proper installation, calibration, and operation. Finally, the commissioning plan should be extended beyond the standard one-year period to ensure consistent, reliable and verifiable performance of building systems.

Step 7: Operate and Maintain

Most sustainable materials are inherently easy to maintain. However, some technologies used in a sustainable design may require more attention than their non-sustainable counterparts. For this reason, the sustainable goals and strategies must be made clear to building users, owners, and maintenance staff. From Rochester Midland Corporation, Steve Ashkin's Operations & Maintenance Management Principles:

1. Commit to people, education and communications.
2. Clean to protect health first and appearance second.
3. Clean and maintain the building as a whole, not just the separate components.
4. Schedule routine maintenance.
5. Plan for accidents.
6. Minimize human exposure to harmful contaminants and cleaning residues.
7. Minimize chemical, particle and moisture residue when cleaning.
8. Ensure worker and occupant safety at all times.

9. Minimize the amount of pollutants entering the building, while maximizing the amount of pollutants extracted.
10. Dispose of cleaning waste in environmentally safe ways.

Step 8: Recycle

After a building has reached the end of its use, it must be evaluated in terms of Reuse-Remodel-Recycle instead of the more common approach of demolition, waste, and reconstruction. If a building is planned to be reconfigurable at the outset, this provides the most useful solution. However, in the event that a building has come to the end of its life cycle, it should be deconstructed, and recycled as much as possible.

References

Engineering and Construction Bulletin (2002-15) detailing use of the Sustainable Project Rating Tool (SPiRiT) www.hnd.usace.army.mil/techinfo/ECB/ECB%202002-15.pdf

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HQ Engineering and Construction News (v. III n. 10) discussing Sustainable Design www.usace.army.mil/inet/functions/cw/cecwe/notes/2001/jul01.pdf

ETL 1110-3-491 Engineering and Design: www.usace.army.mil/inet/usace-docs/eng-tech-ltrs/etl1110-3-491/toc.htm

DD Form 1391 Preparation Planning Charrette Process www.hq.usace.army.mil/cemp/M/Ma/PlChGuid10Oct.pdf

For additional information, contact Annette L. Stumpf; and see Sustainable Design and Development (SD&D); Sustainable Project Rating Tool (SPiRiT) on SD&D; and Best SPiRiT References.

Update on the IAI

By Francois Grobler

What is happening with the IAI and NIBS?

On May 29, 2002, the International Alliance for Interoperability (IAI) merged with the National Institute of Building Sciences (NIBS). It will operate as a council of

NIBS under its current name. NIBS has important products serving the Construction Industry, of which the National CAD standard is perhaps the best known due to its broad appeal. For more details on NIBS, see www.nibs.org. The IAI working as a NIBS Council will enhance coordination with other activities under NIBS and this presents a great opportunity to provide broader, more integrated interoperability solutions to the construction industry.

Since 1995, the North American Chapter of the IAI, has worked as an independent body to develop and promote the use of global standards for the automated exchange of data among computer applications such as CADD, cost estimating, permitting, scheduling, and O&M software. Previous articles in EAR described the goals and achievements of the IAI – see IAI Introduction (Spring 2000); and IAI Update (June 2001).

What does the change mean to the way the IAI operates?

There will be a number of administrative changes internal to the IAI, but externally few changes will be noticeable. The former IAI Board of Directors will continue to function as the IAI Council's Board of Direction, under NIBS. The technical work of the IAI will continue essentially unaffected by the change except for an expected increase in activity due to the greater industry reach of NIBS. In the past, NIBS has received several federal and congressional grants to perform construction industry related developments and NIBS is planning to focus on raising funding for IAI development from such sources.

At the international level, there will also be little change. North American IAI members will continue to provide leadership and serve as chairs of the IAI International Council (IC) and IAI International Technical Management (ITM). Patrick MacLeamy (Chief Operating Officer of HOK) serves a Chair of the IC, where common decisions are made among the independent regional IAIs, and I[1] will continue to serve as Chair of the ITM.

In the News at the IAI

- Software vendors are making good progress in implementing the latest IFC capabilities (IFC2x) into their software. Autodesk (AutoCAD), Bentley Systems (MicroStation), GraphiSoft (ArchiCAD) and Nemetschek (All Plan) all have prototype systems up and running. These "Big CAD" and other vendors are expecting to start software testing by the end of Summer 2002 and software certification by late 2002. This means that commercial software with IFC2x compatibility should hit the marketplace by the 2nd quarter of 2003. The Implementer Support Group (ISG) website maintains a table of implementing software vendors – see: http://www.bauwesen.fh-muenchen.de/iai/ImplementationOverview.htm

- Software from the BLIS (Building Lifecycle Interoperable Software) implementers group is available now and many pilot projects are ongoing world-wide. BLIS is a coordination project—coordinating the implementation efforts of vendors seeking to support IFC R2.0, and planning for IFC2x applications is currently ongoing. Applications from BLIS companies began shipping in 2001. While the BLIS project participants are IAI member companies, BLIS is not an IAI project. For information on BLIS see http://www.blis-project.org. In the US several government agencies have started pilot projects, and we hope to collect information about these and other pilots for display on the International IAI website (www.iai-international.org) Currently listed pilots are available at http://www.iai-international.org/iai_international/Marketing/Pilots_List.jsp
- The most recent public IAI Conference took place in Espoo, near Helsinki, Finland, on April 23, 2002. The Conference had about 300 in attendance and many very interesting presentations were made. The emphasis in the presentations were on pilot projects, a shift from previous conferences where software demonstrations dominated. The conference program and most of the presentations are available on http://cic.vtt.fi/niai/IAI_Summit_2002.htm. The second presentation in the second session by Dr Vladimir Bazjanac, for example, detailed a design of a building using interoperable software. There are several other interesting presentation that you may want to look at, for example the CIFE/VTT study by Tapio Koivu "Foresight Study on Product Modeling and Interoperability". The last presentation "IFC Pilot Project - Headquarters for the Danish Broadcasting Corporation" by Jan Karlshoej, provides details on the pilot project I showed you on the IAI international website.
- Perhaps the most interesting was first presentation by Jukka Pekkanen of the Confederation of Finnish Construction Industries. (Unfortunately it is not available on the website.) They have formed a confederation of essentially the entire Finnish construction industry and are banking their future on IFC-based life-cycle facility delivery and management, so much as expecting that the design-build-manage approach will become the norm.

Whatever happened to aecXML?

Before the dotcom meltdown, aecXML was on everybody's lips in the construction industry. XML was touted as the silver bullet of interoperability in the construction industry and everybody wanted a piece of it. So, whatever happened to aecXML? In the following section, I'm presenting a brief discussion of the evolution of aecXML, followed by an overview of current status of aecXML prepared by Steve Segarra, the chair of the aecXML Technical Committee.

aecXML was constituted as an IAI Domain Committee in early 2002, after Bentley Systems and other initial supporters decided aecXML needed a place under the interoperability umbrella the IAI offered. Works started with seven working groups in January 2000, but by April 2002 the dotcom bubble had burst. aecXML was severely affected by the demise of many of its former supporting firms and progress in the working groups languished.

Meanwhile, an aecXML technical committee was formed because we realized that there were a large number of issues to be resolved: what aecXML should look like, what XML already defined in industry could be adopted for use in aecXML, what does aecXML compatibility really mean, how it should be a part of overall interoperability (e.g. the IAI's Industry Foundation Classes (IFC)). The Technical Committee wrestled with these issues and made significant progress over time. Now documents describing the aecXML approach to these issues are in the final stages of discussion and release for public comments is expected by end of summer 2002. You may view the current working documents on http://www.iai-na.com/domains/aecxml/tech/aecxml_tech_documents.html

The AGC (Associated General Contractors) has organized a taskforce that will be working on e-commerce aecXML standards for the construction industry. This work has already started with pilots for PO's, invoices, RFI's, and payment applications. By early September the work should wrap up with a charrette that should produce the actual aecXML schemas. AGC hopes to put the first of these schemas in use by fall of 2002. These schemas will form the nucleus of XML for e-commerce in the building industry, that is coordinate with the IFC model. This means that information from aecXML sources should be directly usable in IFC applications, providing a much more integrated and interoperable information environment for the AEC industry. Any reader with an interest in participating in this effort is welcome to contact me (Francois Grobler, 217.373.6723, f-grobler@cecer.army.mil)

There are several other activities going on with aecXML in coordinating with other XML developments. The IAI and FIATECH started to consider a common basis for the XML they develop to ensure compatibility. The same is true with a major effort by the lumber supply chain. This collaboration will ensure that the "hand-off" of information between the lumber suppliers (supply-side) and contractors (demand – side) will be effective and hopefully seamless.

A number of industry forces have aligned in a favorable way to make this a great opportunity for success in e-commerce for the construction industry. The current outlook for aecXML looks very good. For more details on aecXML I am including Steve Segarra's document that I previously mentioned.

aecXML Domain Summary

By Steven Segarra,
AecXML Technical Committee Chair
Industry Alliance for Interoperability
December 2001

This document sets out the current state of the aecXML effort, the aecXML Domain goals, and the strategy for achieving them. It also summarizes many of the observations of the members of the committee and explains why the aecXML standard is not only a necessary technology for the AEC, but also a vital one, powered by immediate market needs. In this respect, I have learned quite a lot from the committee members, and hope I have been able to pass their perspective along here.

Rationale for aecXML

There are tremendous efficiencies to be gained by removing the friction from the AEC supply chain. If you are a materials supplier, being able to sell your goods in an electronic market eliminates brokers and fundamentally changes an industry that works on commission. If you are a contractor, being able to control long lead-time design items like structure steel leads to project efficiencies that let you tenant buildings earlier and release capital to other projects.

There are powerful industry forces at work to bring this change about sooner than later. Tom Leete of Builders' FirstSource had the most succinct explanation of why.

Fear. Every player in the AEC industry, right up to the largest, knows that only a few companies in the industry will remove the friction from their processes, improve their margins, and win. The rest will not be in business in seven years. It is not love of the technology or even profit margins per se that is driving the interest in standards. It is simple survival.

Take for instance, the seven largest lumber distributors in the US. These corporations move $50 billion in goods a year, and are bitter competitors in the market. It takes a watershed event to get them in the same room. Nevertheless, they have recently come together to unify their eBusiness standards via the non-profit ProExchange organization because they all see the writing on the wall.

The effort showed an unexpected but immediately tangible byproduct to standardization: The mills were able to fund the automation effort just by licensing the data mining rights to the auxiliary products—tools, saw blades, and the like. That is, the mills found they could pay for the entire effort by giving use rights to data that is not even related to their core lumber business.

The ProExchange effort illustrates the rationale for automation, but it also illustrates some of the challenges. For instance, once all of the different grading agencies are taken into account, 4'x8' plywood requires 42 attributes to describe its properties to the market. There is no existing eBusiness standard that captures this information.

Moreover, 12 of the attributes are not for the benefit of the mills "upstream" the process but for the "downstream" users such as inspectors and yard supervisors. The significant consequence is that no one single company had the information at hand to design an effective standard because no single organization owns the entire process from start to finish. There was no way to approach the problem except with a consortium.

The conclusions are:

- Standardization is a must. Even if there were no aecXML effort, industry needs will pull something very much like it into being in short order.
- The AEC industry has its own intricate demands, and as a consequence requires its own data exchange standard.
- The process automation benefits as well as the derived benefits from working in scale make inter-company cooperation a win. A business based on an ad-hoc schema established between two or three companies will not be able to

compete in the market against one based on one promoted by a consortium, as it will give participants access a larger market.

- No one company or industry group has in-and-of-itself the domain knowledge to design a schema that effectively delivers process automation benefits. Cooperation through a non-profit organization is a must.

2001 aecXML Domain Activities

2001 was a challenging year for the committee. The tremendous momentum the effort had when the IAI took over the aecXML standard was interrupted by the contraction of the eCommerce bubble, which caused significant changes in membership. Later in the year, the consequences of 9-11 delayed scheduled events.

However, the committee has refocused and is now back in full operation. It has a clear set of goals and procedures, a fast-tracked schedule, and a membership that fully intends to produce results within a timeframe that will enable the diverse XML industry efforts already in-play to harmonize with and be informed by a meaningful standard.

In the most recent meeting on December 11th, 2002, the committee listed the action items needed to finalize the core documents detailing the procedures and approach, and it adopted the Association of General Contractors' proposal for making request for information, purchase orders and payment applications the next set of messages to address.

If I could summarize in a word the attitude of the current industry—and by extension the aecXML committee drawn from it – the word is "focused." In previous years, many approaches to the Internet and eCommerce were exploratory, Darwinistically filing niches in parallel to see which schema would survive. In contrast, current efforts are directed, and aimed at the specific business processes that will yield the highest return in short order.

Goals of aecXML

As a result of this focus, the committee is concentrating on the areas of key impact to the industry, namely those commonly used transactions that:

- Contain AEC-specific information and
- Represent a transfer or message
- Between existing automated systems

- Of a limited amount of information
- For a key purpose, usually supply chain or financial information
- In an under-served sector that, in-and-of itself, provides a compelling reason for automation.

Each of these points deserves some discussion as they each relate to the impetus for defining and adopting aecXML. They also illustrate the positioning of aecXML relative to other standards and technologies.

Contain AEC-specific information. aecXML focuses on AEC-specific transactions to avoid duplicating work already in an established standard. However, there are AEC-specific needs that impact both the business documents and the elemental parts of the standard.

Take invoicing, for instance. If you are a contractor, you deliver based on phase, you invoice based on phase, and if your invoices do not to include AEC-specific information like phase or release of lien—you will not be paid. As mentioned above, other characteristics such as the 42 attributes of 4'x8' lumber, are not captured by generic parts catalogs. aecXML can build on standard definitions—such as the UN's ebXML, Arriba's cXML, and the ifcXML produced by the IAI—but must include distinct refinements before these transfer standards truly deliver in an AEC setting.

Represent a transfer or message. aecXML is a standardized means of communicating information in a business transaction, not a repository for holding it. In this sense, aecXML is much different from the IAI's Industry Foundation Classes (IFC's), which could be seen comfortably supporting a model server holding all of a project's design data.

Between existing automated systems. This statement relates to approach. aecXML takes an evolutionary approach it automates pressing needs for data transfer needs between existing software systems—such as transfers between existing order and invoicing systems or between an existing architectural and estimating package. This is in contrast to a revolutionary approach, which would suggest the redesign of the existing billing, architectural, and estimating software to achieve optimal efficiency.

Given the timeframe and the nature of XML transfers, the evolutionary approach is more appropriate and does not preclude future advances. For instance, if a consortium of companies begin with a full invoice process, and then later evolve their agreement, they can use the shipping notice in place of the invoice (akin to the

ANSI X12 evaluated settlement receipts process), and eliminate an entire step in the process. However, the initial form of the standard let them begin developing the trust in the technologies and their business partners they need to get the whole process started.

Of a limited amount of information. aecXML is focused on relatively light payloads for facilitating specific eBusiness transfers. Within a defined business process, much of the information is understood from context, and you can achieve dramatic process improvements with a very focused transfer.

Take the example of estimating. In an aecXML or "thin pipe" model, the architect would send the estimator an extract representing those parameters and a subset of the model that the estimator would find useful. The architect represents that this data is accurate. The estimator would then do their own checks on the data, and then send back an estimate that they will stand behind.

In contrast, within a "thick pipe" or model-based approach, the architect would save the data to the project model, and send a notification to the estimator that the changes were ready. The estimator would add their results directly to the model.

The thick-pipe model can in theory produce additional efficiencies if allowed to revolutionize existing practice before adoption. However the thin-pipe model allows process improvement appropriate for immediate adoption: It makes use of existing procedures and practices for submissions and revision control; it clearly separates legal and contractual responsibility; and it is more easily accommodated by existing software.

For a key purpose. The aecXML projects are chosen based on what is specifically needed to make a key business process, such as purchase orders and payment applications, work in an AEC environment. This is, perhaps, distinct from the choice of IFC projects, which are sometimes chosen to produce the most design information for the underlying model.

In an underserved sector. The aecXML projects are complementary to existing software packages; they provide transfers between them, not new ways of doing their work. This focus means that if an automation need is already adequately served by existing packages, it is not an area of inquiry for the aecXML domain. Returning to our example of cost estimating, aecXML may focus on the needed transfers to existing cost estimating packages, or transfer formats for passing the results back, but the schema and objects used by the cost estimating is beyond the scope of aecXML.

Strategy for aecXML

aecXML intends to be a practical standard worthy of immediate adoption rather than an example or prototype. To achieve this end quickly, the aecXML strategy is to:

- Use ebXML or cXML as an existing library of core eCommerce objects;
- Use ifcXML as a existing library of building objects;
- Concentrate on the payload of messages rather than the transaction framework, which can be Microsoft's BizTalk, ebXML, etc., and
- Take a use-case driven approach in order to illustrate that the aecXML definitions are both appropriate and necessary to enable a type of information transfer that does not currently exist.

The strategy is to use the base elements that are most likely to win approval in the industry. These are the existing eCommerce standards for the business objects and IFC for building objects.

That said, it is good to note that there are different demands on the IFC and the aecXML object hierarchies. The IFCs use a deep object hierarchy appropriate for an interactive project object model. aecXML uses a shallow object hierarchy appropriate for data transfer. A consequence is that the relationship between aecXML and ifcXML is a mapping of the deep IFC hierarchy to the shallow aecXML hierarchy rather than a one-to-one usage of ifcXML as it stands. aecXML may flatten portions of the object hierarchy by including "parent" object attributes and geometries in the "child" definitions in order to make the resulting standard more tractable to existing systems.

The choice to concentrate on the payload of the message rather than the automation framework also speeds aecXML development work. The flexibility of XML makes the choice of framework fairly arbitrary, and avoiding framework choices keeps the aecXML standard from making a choice that has implications for system selection, budget, and other criteria not central to the standard.

The use case approach gives not only a priority for the committee's work but a clear starting point and rationale for adoption. The use cases also clearly indicate what part of the entire aecXML standard any company must support in order to make use of the standard. As such, you can adopt the aecXML standards incrementally.

Conclusion

Demand within the AEC industry will bring aecXML, or something very much like it, into being. The IAI has the appropriate experience and organization for bringing the diverse industry groups that must cooperate to make a workable standard. The IAI also has a domain organization that can organize practical action towards getting the standard developed and accepted, and the aecXML domain committee is taking the focused steps to making the standard a reality.

[1] Francois Grobler, ERDC-Champaign, has served a chair of (ITM) since July 2001. He has also served as Technical Coordinator for IAI North America since October 1999.

Searching for Installation Sustainability in an Encroaching and Transforming World (DRAFT White Paper)

by

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Executive Summary

This paper defines installation sustainability as a condition in which an installation is able to fully execute its present missions without compromising either the

installation's ability to accomplish future missions or the ability of the installation's neighboring communities to realize their aspirations. Therefore, installation sustainability emphasizes mission requirements, while recognizing the linkages we must establish and maintain to sustain readiness and ensure the long-term viability of our installations and communities.

Sustainability requires an integrated understanding of the significant issues that impede, or may do so in the future, our ability to maintain readiness and meet mission requirements. This is a complex task because these significant issues may emerge from any of the three primary dimensions of sustainability (economic, socio-political, environmental). Furthermore, we must frame any analysis within a specific footprint (spatial scale) and a specific timeframe (temporal scale). From this understanding, we can develop stationing plans and installation master plans to resolve these issues and move us toward sustainable operations and mission capabilities.

This paper outlines an approach to sustainability planning and analysis from multiple levels: strategic stationing actions, installation planning processes, and integrated management systems. We suggest that implementing sustainability requires integrating its principles in a formal and explicit manner, within the decision-making processes at all three of these levels, not just any one of them on its own. This means that the value and impact of an effort to make sustainable stationing decisions for an installation will be substantially reduced if the installation's master plan is not framed within the context of sustainability and explicitly linked to the stationing plan. Similarly, a sustainable installation master plan is significantly diminished in its effectiveness if management systems and individual projects are not framed and developed within the context of sustainability.

Thus, stationing plans and analyses must incorporate sustainability principles into strategic-level decisions. This planning process should identify the breadth of stationing options, given the total asset inventory, and select the scenario that allocates military assets (people, equipment, facilities, ranges, etc.) to optimize mission capabilities. This process must address the ability to sustain those assets on viable installations over the long term. The Army Stationing Strategy also should provide guidance to future base realignment and closure (BRAC) processes, as proposed by the Efficient Facilities Initiative (EFI).

Sustainability analysis can identify reasonable (and viable) stationing options and evaluate alternative stationing scenarios. As a planning and decision-support document, The Army Stationing Strategy can support strategic planning and decision-making, providing a general framework, and outlining the decision criteria (such as sustainability factors) for alternative evaluation. Efficient, focused stationing planning and analysis should assess baseline conditions and produce an optimal match between national security objectives, programmed force structure, and existing installation infrastructure—to include all physical assets, both built and natural.

In turn, sustainable installations support military readiness into the indefinite future, without compromising environmental quality or community quality of life—both military and civilian, inside and outside the fence. Army installations must develop and implement an integrated long-range (25-years) strategy that will achieve this objective; and then develop, resource and execute short-range (5-years) action plans to transform, over time, into sustainable installations. Installation planners, analysts, residents, and operators must work creatively with surrounding communities to focus regional investments, including those of The Army, on collaborative planning and management activities that promote long-term sustainability of the installations and surrounding communities.

The installation master plan—the comprehensive plan in civilian communities and the general plan in the Air Force—should integrate various planning and analysis requirements, eliminating redundancies and capitalizing on leveraged, combined resources and aligning community objectives. Master plans are the blueprint to guide the integrated systems or processes that manage objectives, prioritize resources, assign responsibilities and evaluate activities in support of a unified theme: installation sustainability.

Sustainability serves as a compass to focus installations on doing the right things (i.e., effectiveness), not just doing things right (i.e., efficiency). The installation master plan should integrate strategic planning across various installation components—e.g., facilities, infrastructure, ranges, ecosystems, etc.—analyzing impacts, assessing risks, and accounting for interrelationships among mission, socio-cultural, economic and environmental aspects, an original goal of the National Environmental Policy Act (NEPA). Using sustainability as an organizing principle, an " installation sustainability master plan" (ISMP) could concurrently meet the needs of both strategic master planning and NEPA. The ISMP is instituted through the installation's integrated management systems, based on the "ISO" architecture, providing structure and discipline to ensure implementation and evaluation toward the desired (sustainable) end-state.

This sustainability planning and implementation process should align and integrate installation strategic master planning with NEPA and ISO management standards (e.g., ISO 9000 and 14000) as part of a single, cost-effective (yet comprehensive) process that supports the long-term viability and sustainability of Army installations. And it is a process that should guide investments and provide a framework for the adaptive management of installations and continual improvement of operations.

1. INTRODUCTION

1.1 Purpose

Within this paper, we define sustainability as it pertains to Army installations and their relative ability to support current and future mission capabilities. We briefly discuss sustainability principles and business practices, which lead to enhanced operational effectiveness, increased resource efficiency, minimized waste production, optimized lifecycle costs, strengthened community relationships, and restored ecological functions. We also provide an overview of the lessons learned from corporations that have integrated sustainability into strategic planning and daily operations. Finally, we propose three significant domains (i.e., stationing analysis, master planning and management systems) through which to incorporate sustainability into strategic and operational levels of Army installation management. In sum, we convey the essential planning, analysis and management approaches required to prevent constraints to current and future mission, thereby ensuring the long-term sustainability, and therefore viability, of our installations and operations.

2. CONTEXT

2.1 Definitions

2.1.1 Sustainability

Sustainability is a condition in which a system is able to continue functioning into the future without being forced into decline through the exhaustion or overloading of the key resources on which that system depends (Gilman 1996; AIA 1996). While this definition is gaining acceptance among various academic institutions and professional associations, the World Commission on Environment and Development (WCED), provides the most frequently quoted definition of sustainability:

"…meeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). This definition adds the ethical dimension of responsibility beyond the narrow self-interests of a particular system to include the broader consideration about the ability of cohort systems and future systems to realize their aspirations as well.

2.1.2 Systems

A system is most commonly defined as a group of interacting, interrelated, or interdependent elements forming a complex whole. Under this definition, military installations are certainly systems, operating within a larger regional and global system, which can be viewed in terms of their basic physical elements: facilities, infrastructure, ranges and ecosystems. And each of these elements is a system unto itself, but interacting with one another in support of a common objective—i.e., supporting the required mission capabilities of the soldiers and civilians stationed (or employed) on the installation. In addition, installation systems and their respective elements function within a community and regional context, from which sustainment must be derived.

Sustainable systems presumably function or operate at optimal levels over the long haul, which suggests an adaptive capability within a dynamic environment. This ability to adapt to changing conditions within the environment often distinguishes sustainable systems from non-sustainable ones. As resources become unavailable (for whatever reason) an adaptive system identifies substitutes, or evolves such that it no longer requires that particular resource. But there are no substitutes for some essential resources, and even the most innovative and adaptive systems cannot overload or exhaust these critical resources without threatening long-term viability.

2.1.3 Resources

There are four basic categories of resources that may become unavailable or inaccessible over time, thereby leading to decline of a given system, such as a military installation. When considering installations as sustainable systems, these four categories can be viewed as different forms of capital (Hawken et al. 1999): social or human capital (e.g., people, knowledge, culture), physical or manufactured capital (e.g., buildings, infrastructure, machines), economic or financial capital (e.g., money or investments) and, finally, natural capital (e.g., natural resources and living systems, including the ecological services they provide, such as clean water and CO2 absorption). These resources, or forms of capital, supply the system with the support and nourishment it needs to remain viable, and therefore sustainable, over time.

2.1.4 Installation Sustainability

Within the context of military installations and mission capabilities, sustainability planning must support present mission requirements without compromising the ability to meet future mission requirements. But this emphasis on sustaining the mission must recognize and respect interdependence with the natural and built environments—including the surrounding community, the regional ecosystem, and other significant resources—within which Army soldiers and civilians live, work and train. Installation sustainability also requires focus on the social, economic and physical well being of Army soldiers and civilian personnel, their families and community members, all of whom are impacted, directly or indirectly, by installation planning, development and operations.

In short, sustainable installations must achieve and maintain optimal levels of military readiness into the indefinite future, without eroding environmental quality or compromising community (military and civilian) quality of life. Installations must clearly define what is required to reach this objective, develop integrated strategies that identify long-range targets, and execute resourced action plans to enable transformation over time toward a well-defined, sustainable end-state.

2.2 Principles

The literature on sustainability principles is vast. There are countless books, articles and presentations discussing the complexities and intricacies of sustainability, and there are various frameworks for sustainability, each describing the underlying principles and operating assumptions. But there are some common elements and leading frameworks that provide the basic foundation for understanding sustainability within most contexts.

At the risk of oversimplifying the concept, this section briefly highlights sustainability principles as articulated in three popular texts (Nattrass & Altomare 1999; RMI 1998; Hawken et al. 1999). The first text describes a framework (The Natural Step) for sustainability, based on basic scientific principles, and outlines the four system conditions that must be met to ensure sustainability. The next text references sustainability within the context of green development, integrating ecology with real estate to achieve multiple benefits. And the final text argues for sustainability as the organizing principle for the next industrial revolution, based on natural capitalism as an evolution of capitalism as practiced in the world today, which the authors argue fails to account for growing scarcity of the most critical form of capital—i.e., natural capital. Since these sustainability principles are merely highlighted in this paper, readers are encouraged to read these texts for detailed discussion and more in depth explorations of sustainability.

2.2.1 The Natural Step

The Natural Step (TNS) is a science-based approach to understanding the requirements of a sustainable society. Karl Henrik Robèrt, a Swedish oncologist, developed the TNS framework during the late 1980s and early 1990s to educate people (from Kindergarten age children to the most senior adults) on the fundamental principles of science, which frame the necessary system conditions for sustainability. The Swedish government formally adopted TNS as a national program, and several leading (international) corporations are incorporating this framework into all aspects of their planning and operations.

TNS is based on four basic scientific principles (Nattrass & Altomare 1999), which are in turn derived from fundamental laws of nature (e.g., the Laws of Thermodynamics). These scientific principles are summarized as follows:

- Nothing disappears. Matter and energy cannot be destroyed, according to the first law of thermodynamics and the principle of matter conservation.
- Everything spreads. Matter and energy tend to disperse (the second law of thermodynamics), which means that sooner or later matter introduced into society will be released into natural systems.
- Concentration and structure give value. Material quality can be characterized by the concentration and structure of matter; we consume only the qualities of matter and energy.
- Photosynthesis creates structure and order. The sun-driven process of photosynthesis is responsible for almost all increases in net material quality on this planet.

Based on the definition of systems presented earlier, the earth is perhaps the quintessential natural system. According to the TNS framework, there are four fundamental “system conditions” that must be met, without exception, to ensure sustainability for the earth as a total system (Nattrass & Altomare 1999; Burns 1999; Rosenblum 2000).

- Substances from the Earth’s crust (the lithosphere) must not systematically increase in the ecosphere. Fossil fuels, metals and other minerals must not be extracted at a faster pace than their slow redeposit into the Earth's crust. These substances have accumulated beneath the earth's surface over the course of billions of years, and they are sequestered there for good (ecological) reasons.

- Substances produced by society must not systematically increase in the ecosphere. Human-made substances must not be produced and accumulated faster than they can be reintegrated back into natural cycles, assuming they can be assimilated by nature at all. Natural systems, as a whole, have an enormous capacity for resilience, but they do have limits in their capacity to absorb the material wastes and chemical by-products resulting from human activities.
- Nature's functions and diversity must not be systematically impoverished by physical displacement, over-harvesting, or other forms of ecosystem manipulation. Ecosystems cannot be harvested or manipulated in such a way that systematically diminishes productive capacity and diversity. Much of the resilience and productive capacity (i.e., the ability to provide essential life-supporting ecosystem services) of the earth's natural systems comes from its diversity and built redundancies. Destroying biodiversity and complexity can disrupt natural system capacities and lead to ecological instability and (ultimately) decline.
- Resources must be used fairly and efficiently in order to meet basic human needs worldwide. Basic human needs must be met for all people, using the most resource efficient methods possible. This system condition is highly interdependent on the preceding conditions, connecting the human aspects of sustainability into the bigger picture. There is both a technical and social dimension to this system condition, emphasizing greater resource efficiency through improved technologies combined with the equitable distribution of resources to meet all people's most basic needs. As Rosenblum (2000) points out, "if basic human needs are not met, sustainability goals, ecosystems, and ecosystem services suffer."

2.2.2 Green Development

Rocky Mountain Institute (RMI 1998) uses the term "green development" when describing sustainability as it applies to the built environment. While green development focuses primarily on integrating sustainability with real estate development, its principles apply to other contexts as well. Green development integrates environmental and community quality objectives such as energy efficiency, ecosystem restoration, community cohesion and transportation alternatives to produce multiple benefits from individual features and reduce environmental impacts from development. It is based on four basic "process elements": (1) whole-systems thinking; (2) front-loaded design; (3) end-use/least cost considerations; and (4) teamwork. The following is a summary of the basic process elements of green development:

- Whole-Systems Thinking. This type of thinking is a process that actively considers the interconnections between systems and seeks solutions that address multiple problems at the same time.
- Front-Loaded Design. This type of design considers how to optimize lifecycle costs and resource impacts during the early planning stages to improve the overall sustainability of the development project.
- End-Use/Least-Cost Considerations. This element focuses on meeting the desires and needs of the end-user at the least cost in financial, social and environmental terms.
- Teamwork. This element points to the value of stakeholder involvement in the planning process, representing diversity in perspectives and skills from multiple disciplines (e.g., engineers, biologists, sociologists, etc.) required to visualize and achieve more sustainable developments.

2.2.1 Natural Capitalism

Natural capitalism is based, in part, on the premise that our economy has historically failed to accurately account for capital in its various forms: social or human capital (e.g., people, knowledge, culture), physical or manufactured capital (e.g., buildings, infrastructure, machines), economic or financial capital (e.g., money or investments) and, finally, natural capital (e.g., natural resources and living systems, including the ecological services they provide, such as clean water and CO2 absorption). In fact, Hawken et al. (1999) argue that the world economies, especially the U.S. economy, are biased almost exclusively toward financial capital, with little to no accounting of the other forms of capital.

Another operating premise of natural capitalism is that the industrial revolution emerged from historic conditions of abundant natural capital (i.e., resources such as coal and timber) amidst limited human capital (i.e., people in the workforce). Therefore, technology was introduced to enhance the productivity of this limited human capital in its exploitation of the (seemingly) abundant natural capital. But over time, natural capital has become more limited due to resource consumption and waste generation, while human capital has become rather abundant with the population explosion over the past 100 years, though mismatch exists in some economic sectors.

Sound economic philosophy suggests the need to place emphasis where resources are scarce, which has shifted over time from human to natural capital. In response to the unsustainable conditions illustrated in Figure 1 above, Hawken et al. (1999) articulate four principles of what they profess to be a more natural form of capitalism, as an effective framework for understanding and applying sustainability. These principles of Natural Capitalism, which the authors suggest will fuel the next industrial revolution, are summarized below.

- Dramatically increase resource efficiency and productivity. There is a growing recognition of our inefficiencies as a society, particularly manifested in our industrial processes and our built facilities. Hawken et al. point out countless examples of Factor Four (75%) improvements in resource efficiency and productivity. In fact, there is potential in many economic sectors for Factor Ten (90%) improvements.

  As an illustration of this principle, Rocky Mountain Institute (RMI) constructed its headquarters in Snowmass, Colorado using no mechanical heating, ventilation and cooling (HVAC) systems. RMI completed construction on this building in the early 1980s, using super-insulated walls and high-efficiency windows, combined with site orientation (southern exposure) and building design features (such as passive solar heating) best suited to the cold-dominated climate (where it often reaches -40 degrees). As a result of its efficiencies, the RMI headquarters only spends about $5 per month on its energy bills, while growing tropical fruit such as bananas.

  Such dramatic improvements are feasible for Army facilities as well. Army researchers applied sustainable design and development features to family housing to achieve lifecycle energy reductions of 73%, without increasing the initial cost of the proposed development. This Army example is highlighted further in discussions of benefits (see section 2.4.2 below).
- Eliminate the concept of waste – close the loop by mimicking nature. This principle acknowledges that waste does not exist in nature. Instead, by-products from one natural process serve as feedstock for other processes. There are many lessons to learn from the flow of resources within natural systems as analogues for human generated materials and waste flows.

  Perhaps the most dramatic example to contrast nature's product development from human industrial processes is in the manufacture of Kevlar fibers for bulletproof vests and other protective surfaces. Kevlar manufacturers use many toxic chemicals and apply high-concentrations of heat to produce this fiber, while there are spiders that produce a much stronger fiber by digesting insects at room temperature.

- Focus on service and flow instead of product procurement. This principle focuses on meeting the desires and needs of the end-user at the least cost in financial, social and environmental terms. Amory Lovins, co-founder of RMI and co-author of Natural Capitalism, asserts that "People don't want electricity, coal or oil… what they want are the services energy provides: illumination, cold beer, comfortable living rooms, hot showers, and so on. How can we provide these services…with the least overall cost?" (RMI 1998)

  Interface, Inc. offers the most accessible testimony to this principle's efficacy. The company manufactures carpet tiles, primarily for commercial applications, that are made from recycled fibers and which are themselves recyclable into fibers for more carpet. While this feature is valuable in its own right, the real value to Interface's product is the service provided as an alternative to purchase. Interface leases the "floor covering services" provided by its carpet tiles, retaining ownership of the product and responsibility for lifecycle maintenance, as well as the benefits from continuous material recycling.

  Carpet leasing customers enjoy the services provided by the product, without the liability of maintenance, removal and disposal of the product at the end of its service life. As the carpet is worn in high-traffic areas, technicians rotate the tiles to distribute the wear more evenly, thus extending product life. Interface reclaims the tiles when they've degraded beyond quality standards, and the company recycles the carpet pile fibers into renewed pile fibers and the backing into renewed backing.
- Reinvest in natural capital to restore ecological diversity and productive capacity. This principle is about restoring the scarce biotic resources and ecosystem services (referred to as "natural capital") by reinvesting the profits or retained savings achieved by eliminating waste and less productive (and in some cases, ecologically destructive) processes. Hawken et al. (1999) assert that if natural capital is "the most important, valuable, and indispensable form of capital, then a wise society will reinvest in restoring it where degraded, sustaining it where healthy, and expanding it wherever possible."

Forestry, farming and fishing industries are among the first to recognize the value in this principle and to put it into practice. Using whole-system solutions, these restorative activities can be implemented with relatively low-costs, and in some instances generate substantial savings—though cost is not the overriding driver behind this principle of natural capitalism. Below are two examples extracted from the literature on Natural Capitalism.

- Allan Savory, a wildlife biologist from Africa, studied the migration of large herds of native grazers that co-evolved with the grasslands. He then redesigned ranching practices to mimic this natural co-existence to greatly improve the carrying capacity of the rangelands. Savory found that the natural behavior of migrating herds often resulted in the intense overgrazing of the grasslands, which precipitates the regenerative growth of the brittle ecosystem in a more productive way than current practices, which tend to under-graze the rangelands from an ecological perspective. This finding contradicts traditional concerns about grazing practices, but demonstrates the value in observing ecological relationships to develop appropriate resource management strategies.
- John Todd, a noted biologist and ecologist, applied his understanding of ecological services to develop a natural systems approach to wastewater treatment. Dr. Todd's invention, what he calls a "Living Machine," looks more like a greenhouse than a sewage treatment plant. It uses the gravitational flow of water through a series of small-scale ecosystems, yielding potable water at the end of the proverbial pipe—without using toxic chemicals or generating hazardous wastes.

On a large ecological scale, the U.S. Army Corps of Engineers is putting this fourth principle of natural capitalism into practice with the restoration of the Kissimmee River Basin.

2.3 Practices

There are several lessons learned from the pioneering companies that are instituting sustainability as an integral part of their core business functions. In their analysis of the business case for sustainability, Nattrass and Altomare (1999) identify eight discrete lessons from the corporate pioneers incorporating sustainability into strategic and operational levels of their respective organizations:

1. Moving toward sustainability often means a fundamental change in the culture.
2. Leadership is the cornerstone of any major change initiative.
3. Conscious organizational learning is fundamental for success in making change.
4. The corporate vision of sustainability should be well articulated and aligned with the visions and values of individuals within the company.
5. A common knowledge base about sustainability accelerates involvement and innovation.
6. Feedback reinforces learning and involvement and helps move ideas into action.
7. From a whole-systems perspective, the company is part of a larger system of relationships.

8. The move toward sustainability is an evolutionary shift.

2.4 Benefits

There are many quantifiable and easily documented benefits that emerge from investments in sustainability, along with some qualitative benefits that are more difficult to measure. While there are no perfect (i.e., complete) examples of sustainable practices, there are several examples within the Army that demonstrate the operational, environmental and economic value derived from sustainable approaches to planning and investments. As noted in these examples, sustainability principles can guide investments and management practices to enhance operational effectiveness, increase resource efficiency, minimize waste production, optimize lifecycle costs, strengthen community relationships, and restore ecological functions. These examples demonstrate the efficacy of "whole-systems" thinking, lifecycle considerations and collaborative approaches to simultaneously meet multiple requirements.

2.4.1 Deployable Photovoltaic Technology

Army Rangers are using photovoltaic (PV) technology to generate supplemental power during training and deployments in the field. By using the PV technology, they minimize use of their diesel generators, thereby reducing the logistical footprint associated with generator fuel. This improves operational effectiveness by limiting the heat and noise signatures, thereby improving stealth capabilities. Soldiers also spend less time mitigating noise from the generators, such as digging holes or creating berms to mask the noise and heat, which reduces the overall workload. Based on applications in field and simulated environments, the Center for Army Analysis (CAA) suggests that a photovoltaic power station can provide the primary power source for a Battalion sized unit. CAA confirmed that PV applications in deployments enhanced operational readiness, improved lifecycle cost-effectiveness, reduced significant greenhouse gas emissions and minimized generator fuel requirements.

2.4.2 Green Neighborhood Development

On average, 25% of Army facilities are residential developments for soldiers and their families. Army Family Housing (AFH) is comprised of over 110,000 units, with an average age of 35 years for this inventory. Only 38% of these units rate as adequate under Army standards, and these housing units are very inefficient in resource use (e.g., water, energy and land consumption). The U.S. Army

Construction Engineering Research Laboratory (CERL) developed a Green Neighborhood Planning process, using a “whole-systems” approach, which demonstrates both improved resource efficiency and reduced environmental impacts from family housing developments through integrated design methods and lifecycle costing considerations.

CERL researchers modeled entire AFH neighborhoods to simulate the energy impacts of critical factors like building orientation, envelope insulation and strategic landscaping to evaluate alternative design and development scenarios against traditional approaches. CERL combined these simulations with cost analyses to determine optimal neighborhood layout and housing design for case studies at Fort Hood and West Point. These studies demonstrated significant improvements in quality of life—community connectivity, safety and security, etc.—while dramatically reducing lifecycle energy use (73% less than the baseline), at no appreciable additional cost (within 5% of the baseline).

2.4.3 Zero Footprint Camp

The U.S. Army Materiel Command (AMC) recognizes that traditional waste management methods used for base camp operations are resource-intensive and create a substantial burden on the camps. These traditional methods also depend on contracted civilian waste management services, posing potential risk to the physical security of the area from terrorist activities. In response to these concerns, AMC developed the Zero Footprint Camp (ZFC) initiative to reduce the logistics footprint, operations and support costs and environmental impacts of base camp operations. This initiative minimizes waste by applying “whole-systems” approaches to resource management, finding cost-effective and technically feasible ways to re-process and/or reutilize trash, gray water, black water and food garbage within the camp. While the current ZFC initiative focuses primarily on solid waste and wastewater management issues, the scope could expand easily to broader sustainability considerations.

2.4.4 Private Lands Initiative

The Fort Bragg Private Lands Initiative (PLI) uses a regional approach to managing critical habitat for the red-cockaded woodpecker (RCW), an endangered species. Urban development and commercial timber harvesting across the regional landscape threatens this fragile bird species and its critical habitat. Fort Bragg, like many installations in the southeast, provides a valuable sanctuary for the RCW, a “keystone” species indicating biodiversity and resilience in the ecological region ("eco-region"). Although Army land management practices sustain habitat for the RCW and other threatened or endangered species (TES), viable species recovery planning requires a large-scale, regional approach to reduce fragmentation of RCW habitat within the Sand Hills eco-region. PLI leverages Army resources through a strategic collaboration with the U.S. Fish and Wildlife Service, The Nature Conservancy and other partners, to acquire conservation easements across the Sand Hills ecosystem to provide sufficient contiguous habitat for a viable and sustainable RCW population.

3. DISCUSSION

3.1 Issues

3.1.1 Encroachment Pressures

There is growing concern about the risk to installations and their ability to support mission capability due to increasing pressures or "encroachment" on military training and testing areas. Encroachment is any outside activity, requirement, or pressure that impacts on the ability of military forces to train to doctrinal standards or to perform the mission assigned to the unit or installation. More succinctly, it is anything that inhibits live training and testing as required to maintain readiness. These limitations may come from concern over various issues, such as threatened/endangered species preservation, unexploded ordnance cleanup, electromagnetic frequency and bandwidth demand, maritime ecosystem protection, airspace demand, ambient air and atmospheric quality (including airborne noise), and urban growth.

Clearly, encroachment issues can affect the long-term viability and sustainability of Army installations. But the primary focus on encroachment, to date, is limited to the challenges associated with sustaining training and testing ranges. While these issues speak directly to the sustainability of military operations, they fail to address other aspects of overall installation sustainability. The broader view addresses the planning, development and operations of facilities and infrastructure, as well as environmental management (e.g. biodiversity and ecological resilience) and community quality aspects inherent in base operations and support activities.

3.1.2 "Stove-Piped" Management

Traditional management stovepipes address most individual issues determining the relative sustainability of an installation, and any one of these issues can impede the installation's ability to support its mission long-term. For example, the ability to support a given mission scenario can be hindered by air quality in non-attainment areas, water availability in arid or semi-arid regions, or land availability and use constraints when urbanized areas "encroach" along the fence. Many solitary issues, while manageable (even marginally) today, will become critical to long-term viability (i.e., sustainability) of Army installations. Therefore, solving any one issue in isolation may prove moot or insufficient without simultaneously addressing the other sustainability issues in an integrated fashion.

3.1.3 Tunnel Vision

Installations plan and act, for the most part, in response to requirements—real or perceived. Many requirements (e.g., environmental regulations) have emerged in piece-meal fashion, themselves in response to an identified concern. In traditional environmental management, regulatory requirements are typically assigned to installation media managers responsible for managing the scope of activities that fall within their individual domain (e.g., water, air, waste, etc.). This creates another form of "stove-piped" management, as these media managers focus on a narrow scope of requirements and operational issues, without considering or addressing the inherent (and inescapable) relationships to other requirements and operational issues. This "tunnel vision" limits perspectives and misses valuable opportunities to leverage resources to meet multiple requirements through integrated management.

3.1.4 Short-Sightedness

Federal government budgeting processes are notoriously shortsighted. Even though the Army's Planning, Programming, Budgeting and Execution System (PPBES) is designed to identify resource requirements over the 5-7 year horizon, funding policies prioritize resource expenditures to sustain short-term compliance, limiting installation commanders and program managers in their ability to invest in preventive programs that avoid future costs and/or liabilities, unless there is a compliance issue looming within the next 2 years that the investment would address. "Must fund" compliance requirements, focused on short-range impacts (as opposed to long-term goals), continue to receive funding priority while long-term investments in pollution prevention and resource efficiency (both aspects of sustainability) remain without sufficient resources to capture greater savings opportunities for installations and operations.

Shortsighted funding policies and practices have profound impacts on the facilities development process. For example, additional resources invested in the design and construction can yield significant cost savings over the lifecycle of the facility, particularly during operation and maintenance (O&M). While "first costs" account for only 5-10% of the total cost of ownership for most built systems, O&M accounts for 60-85% of the lifecycle cost. And when only 5-10% of the total project costs are spent, 80-90% of lifecycle costs have been committed (see Figure 2).

It is critical to make initial investment decisions based on lifecycle costs and impacts, rather than first cost considerations, because it is increasingly difficult and expensive to incorporate these implications as the planning and development process proceeds. Presidential Executive Order (EO) 13123 requires federal agencies to use lifecycle cost analysis in making decision about their investments in products, services, construction and other projects to lower costs and to reduce resource consumption. The Federal Facilities Council (FFC) recently validated that sustainable development "best practices" can minimize life cycle cost, improve functionality, reduce energy consumption, and increase asset durability (FFC 2001).

3.1.5 Resource Fragmentation

Installations receive funding through various channels, each with restrictions on use and limitations on mixing the different "colors" of money. Commanders request resources (people, money, equipment) based on identified requirements within each program area or operational category. Under this fragmented system of resource allocation, it is difficult to leverage funds from one source with resources from another source. For example, program managers are limited in their use of environmental money for energy related investments to the extent to which a substantial portion of that investment meets a direct environmental requirement (e.g., a compliance issue or high priority pollution prevention activity). Under this system, program managers protect their proverbial "rice bowls" despite systemic shortfalls in individual program funds that keep installations from moving beyond a reactive compliance posture. While there are legitimate concerns about migrating funds from one program area to another ("robbing Peter to pay Paul") commanders need the flexibility in funding policies to leverage and combine funds to create "solutions multipliers" based on prioritized requirements that meet multiple objectives.

3.2 Opportunities

Sustaining Army installations over the long-term, and therefore ensuring long-term mission capabilities, requires an integrated understanding of the significant issues that may impede our ability to meet current and future mission requirements.

Stationing plans and installation master plans provide opportunities to recognize and resolve these issues and to advance an Army management paradigm that supports sustainability principles and best business practices. These plans should incorporate sustainability as an organizing principle to guide strategic and operational activities, rather than simply collecting dust (as plans often do, only to be revised or revisited when required by law or regulation). In addition to these planning elements, an integrated management system (built on the basic ISO 9000/14000 architecture) can provide the discipline and structure to integrate sustainability considerations into all aspects of installation operations—moving beyond traditional environmental compliance issues to embrace the broader challenges to sustaining the Army mission.

Stationing analyses and installation master plans should reflect the integration of component planning activities (e.g., for ranges, facilities, natural resources, cultural resources, etc.) and focus investments on supporting the long-term sustainability of the installation. In turn, component plans, project designs and completed products, should address sustainability, while supporting the objectives of strategic stationing decisions and comprehensive installation plans, and ensure resource allocation and program execution through an integrated management system. Management systems (e.g., ISO 9000 and ISO 14000) are intended to facilitate the continuous review of execution (i.e., Are we following the plan?), and evaluation of progress toward the desired end-state (i.e., Is our plan effective?). This planning and execution process can become more effective once aligned and focused on the common objective of installation sustainability at all levels of planning, analysis and operations.

In the following sections, this paper discusses each critical domain (i.e., stationing analysis, master planning and management systems) in more detail. It discusses how each domain relates to attaining sustainability objectives and how these domains interrelate. Finally, the paper concludes that The Army must align these disparate planning and analysis activities, focusing each domain on a set of common organizational objectives. From this discussion this paper concludes with some general recommendations for strategic planning and installation management to sustain the Army mission, the built and natural environment, the broad community and our collective well-being.

3.2.1 Stationing Analysis

Stationing analysis is an essential domain for incorporating sustainability considerations into strategic level decisions about installation management and operations. This planning process affords an opportunity to identify the breadth of stationing options, given our total asset inventory, and to select the scenario that allocates Army assets (people, equipment, facilities, ranges, etc.) to optimize mission capabilities without compromising our ability to sustain those assets on viable installations over the long term. The Army Stationing Strategy should provide guidance to future base realignment and closure processes, as proposed by the Efficient Facilities Initiative (EFI). Sustainability analysis for stationing actions can facilitate a process for identifying reasonable stationing options and provide objective criteria for evaluating alternatives.

As a planning and decision-support document, the Army's stationing strategy should provide a general framework that outlines the process for generating options and making decision, to include the criteria that serve as the evaluative basis. It should provide an assessment of baseline conditions and produce an optimal match between national security objectives, programmed force structure, and existing installation infrastructure—to include all physical assets, both built and natural. And the stationing strategy should illuminate the road ahead in meeting anticipated requirements inherent in Army Transformation. Ultimately, The Army needs to create an optimal match between total assets and the support those assets provide to national security requirements today, without compromising abilities to accommodate force structure changes required to meet future national security challenges.

Headquarters sustainability analysis for stationing—whether as part of the Efficient Facilities Initiative (EFI) or Transformation—cannot be unilateral or absolute, given the variability among installations and the local, collaborative nature of many solutions. But the relative sustainability of any given installation can be determined through an analysis of alternative courses of action to overcome or avoid significant issues, and an evaluation of the overall feasibility (due to costs, politics, etc.) of local solutions or mitigation strategies. Stationing sustainability analysis should concentrate on a "red flag" level of analysis, based upon a very broad and general knowledge of limiting factors at candidate installations. The early identification of these "red flags" can facilitate awareness of strategic issues that may require clarification and coordination prior to making final determinations. And these "red flags" can ensure we ask the right questions and focus on those strategic issues that require resolution to ensure long-term sustainability.

In order to support short-term stationing requirements, and allow time for the development of installation plans, the general stationing analysis can be accomplished from an initial matrix that reflects the current knowledge base.

Planners and decision makers can alter and refine this matrix as detailed installation plans are developed and updated. For the stationing analysis the matrix aligns installations along one axis, with sustainability issues along the other, as illustrated (conceptually) in Figure 2.

Each intersection is "scored" as blank, red, amber, or green (RAG). RAG scores reflect immediate threats to an installation's viability or sustainability, potential (or future) threats, and no known threats, respectively. Blank scores imply that issue does not apply to the particular installation. Additional information should be available on each matrix intersection, either in the form of a footnote or, if automated, in the form of a "click" on the intersection to "tunnel-down" and obtain more information. This additional information or clarification would come from detailed installation sustainability master plans, or the current composite knowledge of the installation. This information clarifies the nature of the problem, identifies the means to overcome the issue, and indicates the status of installation efforts to remedy these problems. The objective is to identify potential problems for resolution, which will likely require coordination with the installation.

The U.S. Army Engineering Research and Development Center (ERDC) is creating a sustainability analysis tool, based on the matrix concept developed by the Army Environmental Policy Institute (AEPI) and described above. The intent is to integrate this effort with existing stationing analysis models, such as the Optimal Stationing of Army Forces (OSAF) model, developed by the Center for Army Analysis (CAA), and the Installation Training Capacity (ITC) studies, prepared for the Deputy Chief of Staff for Operations and Plans (DCSOPS). An expanded, comprehensive tool of this type can provide (1) sustainability metrics for optimal stationing, with low-resolution "screening" criteria at the macro level, and (2) high-resolution metrics at the installation level, which feeds multiple levels of analysis. The approach "rolls up" (or aggregates) installation-level analyses into HQDA-level "flags" as sustainability indicators.

3.2.2 Master Planning

Installation master planning is the second critical domain for incorporating sustainability to ensure the long-term viability of Army installations and mission capabilities. While specific regulations and guidance have evolved over the years, the intent behind the master planning process remains consistent. This process ideally serves two critical functions: (1) it assesses factors that may affect the present and future development of an installation, and (2) it forms an official statement of an installation's long-range plans (Keysar et al. forthcoming; Tyler et al. 1992; CERL 1988). Even with the narrowed scope in existing regulations, master plans are still intended to provide "…a blueprint to enable the installation to effectively respond to future Army missions and community aspirations, while providing the capability to train, project, sustain and reconstitute today's force" (HQDA 1993).

Sustainability planning at the installation should reflect the intent of master planning, and it should incorporate the values and aspirations of both internal (inside the "fence") and external (residents from the surrounding community) stakeholders. This planning effort must include all essential aspects of an installation, thereby removing " stovepipe" impediments to produce a sustainability master plan "owned" by all installation organizations. Installation sustainability plans should address the physical components of Army installations (facilities, infrastructure, ranges, and ecosystems), and their interactions and interrelationships, to create a sustainable environment inside the fence, while maintaining an adaptive ability to support current and future mission requirements. This flexible approach to sustainability planning can minimize or eliminate activities that adversely impact the surrounding community and/or regionally significant resources.

While installation sustainability planning requires many steps, the process is derived from the four basic questions that guide most strategic planning processes: (1) Where are we now? (2) Where do we desire/need to be? (3) What must we do to move from where we are to where we want to be? And finally, (4) how do we do we measure our progress, ensuring we are on course toward the target?

Before we begin to plan our future, we describe our baseline conditions. Then we define the desired end-state—i.e., our target objective. This allows us to conduct a gap analysis between the desired objective and our point of departure to determine how far we need to go. We must be able to clearly recognize those things that characterize our desired end-state by identifying its essential elements (i.e., fundamental criteria or metrics for measuring our relative progress toward the objective). At this point, we map the alternative paths (or courses of action) that may lead us to our objective, and we select the optimal path. But before we embark, we identify the impediments we may find along this path and equip ourselves with sufficient resources (e.g., money, knowledge, tools, etc.) to overcome obstacles and reach our objective.

In July 2001, U.S. Army Forces Command (FORSCOM) established an Installation Sustainability Program (ISP), based on the basic steps outlined above. The ISP guides the development of integrated installation sustainability master plans to ensure the long-term viability of critical installations. This initiative directly responds to the Senior Environmental Leadership Conference (SELC) in the spring of 2000, which called for installation-level, integrated environmental strategies that link objectives to resources, define the desired end-state, and actively engage appropriate stakeholders. Under the FORSCOM ISP, these strategic plans focus on the long-term objective of sustainability across all installation operations through lifecycle cost-effective investments implemented over the next 25 years, with specific resource requirements identified in the 5-year installation action plan.

Installation sustainability master planning, as instituted at FORSCOM, is essentially a three-step process that results in an installation-specific plan to ensure long-range viability, to include environmental sustainability. The first step is to assess baseline conditions to identify significant sustainability issues that may impede the installation's ability to meet mission requirements over the next 25 years. The second step is to engage stakeholders at all levels in an on-going dialogue about how to manage these significant issues over the long haul. And the final step is to develop and implement 5-year action plans that explicitly link sustainability goals and objectives to specific actions and resources required for successful execution.

The FORSCOM Commander directed installations to conduct sustainability conferences/workshops and develop sustainability master plans to guide long-term investments over the next 25 years. These strategic plans provide a blueprint to enable the installation to effectively respond to future missions and community aspirations, without exhausting or overburdening resources or diminishing environmental quality. Most importantly, these plans enhance the installation's capabilities to train, project, sustain and transform Army forces over the long-term.

Fort Bragg convened the Army's first installation-wide sustainability conference on 17-18 April 2001. In his message to conference participants, the Fort Bragg Garrison Commander, COL Addison Davis, issued this charge: examine the issues challenging the long-term sustainability of Fort Bragg; determine the end-state we want to achieve; set aggressive, attainable and quantifiable goals; and pull together teams that engage the right stakeholders to ensure that Fort Bragg's history of proud service to the nation, and to the world, continues indefinitely. MG Ryneska, the post's Deputy Commanding General, echoed COL Davis' charge and pointed out that this conference not only positions Fort Bragg for future success and increased funding support in several areas, but also improves the installation's standing and partnerships with regional regulators and surrounding communities.

Marine Corps Base (MCB) Camp Lejeune, in North Carolina, and Homestead Air Reserve Station (ARS), in Florida, both embarked on sustainability planning efforts similar to those at Fort Bragg. These installations are pioneers in the emerging and evolving use of sustainability as the guiding compass or organizing principle to develop and institute integrated, installation-wide (comprehensive) planning. While each installation executed the process in a unique manner, there are common elements articulated in the Homestead ARS plan, but evident in the Fort Bragg and MCB Camp Lejeune plans as well, that clearly align with the basic steps outlined above: (1) develop a vision of the desired end-state (i.e., a sustainable installation) that can be implemented over the next 20-30 years; (2) understand and document the baseline conditions; and (3) develop step-wise goals (and criteria) and an overall strategy to achieve the desired end-state.

These initial sustainability master plans continue to evolve and improve over time. They provide an excellent point of departure for building an effective and strategic planning initiative to sustain critical Army installations and mission capabilities in response to evolving doctrinal requirements. The Army must learn from these precedent-setting initiatives, improve upon them where appropriate, and initiate similar planning to sustain essential installations.

3.2.3 Management Systems

Management systems are the third domain for incorporating sustainability and ensuring long-term installation viability. In order to institute sustainability, the installation master plan must be effectively executed, with integration on various levels. The application of management system standards, such as the ISO 14001 Environmental Management Systems (EMS) standard, affords an excellent opportunity and approach for assuring these objectives are achieved. While no single existing management system standard fully encompasses all the attributes required to thoroughly address the multiple dimensions of sustainability, the ISO 14001 EMS standard provides the best platform from which to base and build an integrated and comprehensive management system. But to prove sufficient for sustainability, an EMS must incorporate more than environmental considerations; it should include social, economic and infrastructure aspects as well.

Ideally, management systems should consistently produce intended or planned outcomes for a given operational focus—quality, environment, energy, sustainability, etc. Various management system standards have evolved as best business practices, to include international standards like ISO 9001 Quality Management System (QMS), ISO 14001 Environmental Management System

(EMS), and Forest Stewardship Council (FSC) certification. They also include national (U.S.) standards like Management Systems for Energy (MSE) 2000, adopted by the American National Standards Institute (ANSI), and Sustainable Forestry Initiative (SFI) certification. Internal standards, such as Army Regulations (ARs), may also constitute a management system standard.

The intent of a "standard" is to provide uniformity. The Greek word "ISO" means equal, alike or similar. ISO standards are international standards designed to provide uniformity in performance across countries, businesses, and organizations. Management system standards have evolved as a means to provide uniform application of best business practices. The process of developing and periodically updating ISO standards is extremely rigorous, and therefore provides a reliable foundation for best business practices, which is why ISO standards have such broad acceptance among business worldwide.

Although ISO 14001 is a resource for establishing management processes to achieve environmental protection and improvement, it does not provide direction on how to protect or improve the environment. Burns (1999) provides the metaphor of comparing an EMS as a sailboat searching for a destination, but lacking a compass to guide it in the right direction. Sustainability principles can serve as the compass, providing direction for the EMS to achieve results that are necessary to truly protect and improve social, economic and environmental conditions required for a sustainable system.

One primary strength of ISO 14001 is the continual improvement cycle—plan, do, check, act," (PDCA). This aspect is expressed within the standard as five discrete phases of an effective management system: (1) policy, (2) planning, (3) implementation and operations, (4) checking and corrective action, and (5) management review. Planning includes identifying significant impacts caused by mission activities, setting objectives (i.e., what to accomplish) and targets (i.e., by how much and by when) for mitigating these impacts, and then allocating resources to achieve the targets. The planning phase aligns well with installation master planning, especially the short-range component where more specific programmatic objectives are defined. As the implementation plan is further detailed into 1-2 year increments for fiscal year budgeting and execution, it better complements the management system cycle of PDCA.

Eccleston (1998) states that environmental planning is perhaps the most important principle of ISO 14001. While the planning aspects of any environmental management system are critically important, Checking and Corrective Action, combined with Management Review, is also very important because it provides the basis for continual improvement through repeated verification and accountability. Checking and Corrective Action provides the mechanism to evaluate whether the plan is being followed (i.e., are you doing what you say you are going to do). Management Review assesses whether or not the actions, based on the plan, are achieving desired or intended results (i.e., is the plan effective), which in turn may require adjustments in the next planning phase. The continual improvement component of ISO 14001 is powerful because of this iterative process that keeps the master plan active, regularly assessing its effectiveness, with periodic updates as needed.

The underlying continual improvement process for ISO 14001 EMS is consistent with the principles of adaptive management, which consist of five basic steps: predict, mitigate, implement, monitor, and adapt (Eccleston, 1998). This aspect of ISO 14001 is crucial to installation sustainability because installations, communities, soldier well-being, nature, and economy are inter-influencing dimensions that are constantly changing. The continual improvement cycle facilitates adaptive management by reviewing changes in operating conditions and then driving appropriate adjustments to stay on the path toward sustainability. With respect to the PDCA-cycle, the Checking and Corrective Action phase of an EMS focuses on short-term issues and actions, while the Management Review phase incorporates both short-term adjustments and long-term strategies.

In order for the ISO 14001 EMS approach to more effectively align with and execute the sustainability master plan, the EMS should expand into a Sustainability Management System (SMS) that includes factors beyond environmental aspects and impacts. As the definition of sustainability suggests, an SMS should take a “whole-systems perspective,” to include impacts on communities, infrastructure, and well-being caused by various mission and support activities. As the management system scope expands, the focus becomes the installation, its mission and its region of influence. Sustainability planning should address current or actual impacts and conditions, and potential future impacts and conditions, defining significance in terms of the probability of occurrence, and the severity of these potential effects. While higher-level, long-term (programmatic) planning and analysis occurs at the installation master planning level, an effective SMS articulates short-term, detailed plans for execution, and provides feedback for future planning (long-term) and analysis.

Because sustainability is comprehensive, it encompasses the interdependence with the natural and built environment, and the social, economic and physical well-being of our soldiers and civilian personnel, their families and the community members. In addition, sustainability makes evident the interdependence of installation management stovepipes and component plans for sustaining the mission. While the sustainability master plan provides the framework to align all these multiple dimensions of an installation, a SMS provides the management structure to guide the on-going coordination among these dimensions that is required to pursue a more sustainable installation. ISO 14001 can be the platform used to develop a Sustainability Management System, by expanding its scope to include not only environmental impacts, but also impacts to the other multiple dimensions of sustainability. In turn, as mitigation strategies are developed, these strategies must ultimately ensure enhanced mission.

4. CONCLUSION

In summary, installation sustainability refers to our ability to maintain optimal levels of military readiness and environmental quality for current and future generations. To achieve this objective we need an integrated analysis of significant issues that may impede our ability to meet current and future mission requirements. This sustainability analysis should result in at least two significant strategies, one which encompasses all Army installations and the other which is customized to each specific installation: a sustainable stationing plan and sustainable installation master plans, respectively. As these plans are articulated, each installation should institute an integrated sustainability management system, which provides an effective vehicle for implementing and monitoring these plans to ensure progress toward stated sustainability objectives and alignment among selected investment priorities.

At the stationing level, the Army needs a strategic "total installation asset management plan" based on a summary analysis of the relative sustainability for each stationing scenario. From this stationing sustainability analysis, planners and decision-makers can optimize the allocation of all Army assets (people, equipment, facilities, ranges, etc.) without compromising the Army's ability to sustain these assets and maintain required mission capabilities.

At the installation level, the Army needs integrated sustainability master plans, reflected in and summarized for the Army stationing strategy. These installation master plans provide a blueprint for responding effectively to future Army missions and evolving community aspirations, while maintaining the capability to train, project, sustain and transform Army forces stationed on the installation.

At the operational level, the Army needs an integrated sustainability management system to align disparate planning, analysis and operational activities toward the common objective of long-term viability and sustainability of essential Army installations. The sustainability management system provides an organizational framework to systematically incorporate strategic (sustainability) planning objectives into day-to-day activities and standard operating procedures.

Sustainability is a critical factor in strategic planning and daily operations to maintain the long-term viability of Army installations and mission capabilities. Sustainability provides an organizing (or driving) principle to guide Army stationing analysis and installation master planning and further align individual installation planning objectives with corporate Army and national policy objectives. Furthermore, sustainability serves as a compass for integrating management systems to ensure congruency between planning activities, resource allocation decisions and day-to-day operations. At the stationing level, sustainability is obviously broader in scope, dealing primarily with major (i.e., showstopper or red flag) issues that will affect the long-term viability of a given stationing scenario. But the issues addressed in the stationing strategy must be framed and articulated through integrated installation-level planning and analyses (e.g., master planning).

This linkage between strategic level decisions on stationing and installation level master planning is essential to successful incorporation of sustainability principles. Installation planners and program managers, working with community and regional stakeholders, ultimately must manage the consequences and sort out the implications of national-level decisions. For instance, stationing decisions, whether for BRAC or Transformation, can lead to conditions at the installation level that are unsustainable, but which can be avoided with sufficient analysis of local conditions.

Sustainability issues cannot be resolved at the strategic level of planning and analysis, but headquarters level planners must be aware of limitations and constraints at the installation level as a matter of informed decision-making. In turn, installations must consider how local decisions align with national (or corporate) scale priorities, and they must ensure long-term viability within the constraints of these priorities. Thus, installations must identify significant issues impacting on sustainability (currently or in the future), develop alternative courses of actions to overcome these limitations, and articulate sustainability action plans to headquarters with accompanying resource requests. Headquarters then can validate these installation sustainability plans and respond with support through funding policies, budget submissions and implementation guidelines.

Sustainable installation master plans must support the mission and provide a basis for evaluating and prioritizing installation initiatives and investments. Then installations must systematically implement the prioritized actions (i.e., programs, projects, tasks) outlined in the master plan and evaluate progress toward meeting planning and management objectives. Installation priorities feed into a management system, which provides the structure and discipline to ensure plan execution. An integrated sustainability management system would provide an organizational structure and implementation process to frame assessments of those installation and mission-related activities that affect resource availability and utilization (i.e., the analysis of significant sustainability "aspects" and impacts), thereby leading to the prioritization of resources for strategic investment to achieve long-term sustainability objectives.

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