Design Approach *(Cont.)*

- **Building Information Modeling (BIM)**
  - **Used extensively to improve the efficiency of design and construction processes by coordinating building systems**
  - **Used to generate 3D models for design development, design verification, construction simulations, walk-through, and mock-ups.**

Design Strengths

C-8 & C-9 Building Comparisons

C-9 uses structural steel (bar joists) and exterior block/brick walls;
harder to use and time consuming

C-8 uses structural steel and precast panels;
easier to assemble and less weather dependent

Strength

Hallways: Terrazzo or Ceramic finish

Strength

Energy Savings

- **Overall lighting reduced due to use of complementing modular furniture lighting**

Strength

Effective Room Layout Importance

- **Components of room need to be properly integrated**

Strength

Durability & Sustainability: Key to Maintaining High Quality Level

- **10’ high ceilings and impact-resistant GWB in corridors used to make more durable for troop usage**

Construction Delivery

Construction Delivery

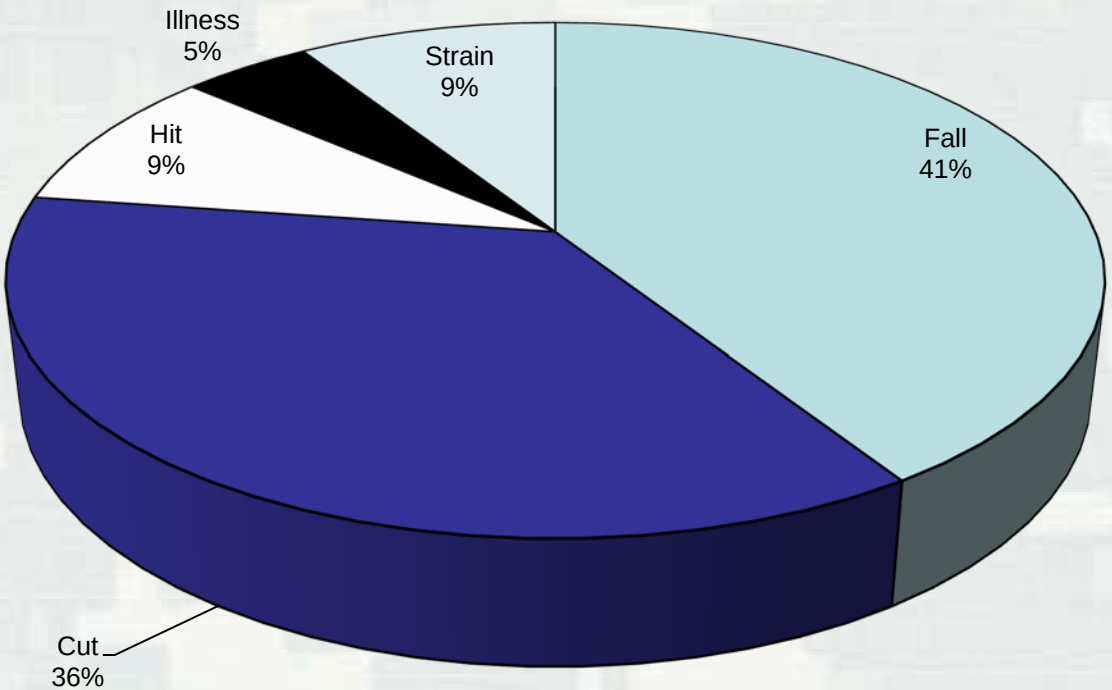
- Safety program specifics
- Effective Project Schedule Management
  - In-house scheduler, iterative planning with subs, & Critical Path Management
- QC/QA Program
  - Use of Mock-ups
  - Specialty Inspectors (roof, steel erection, concrete, geotech)
  - Three Phase Inspection: Preparatory, Initial, and Follow-Up
  - Window testing
  - Door adjustments
- RED ZONE – Last Three Months of Project
- Building Commissioning (Three Levels, including air barrier test)
- Monthly LEED Reviews
- Lessons Learned

Reportable Safety Incidents

Minimizing injuries is crucial objective

TOTAL SAFETY REPORTABLES: 22

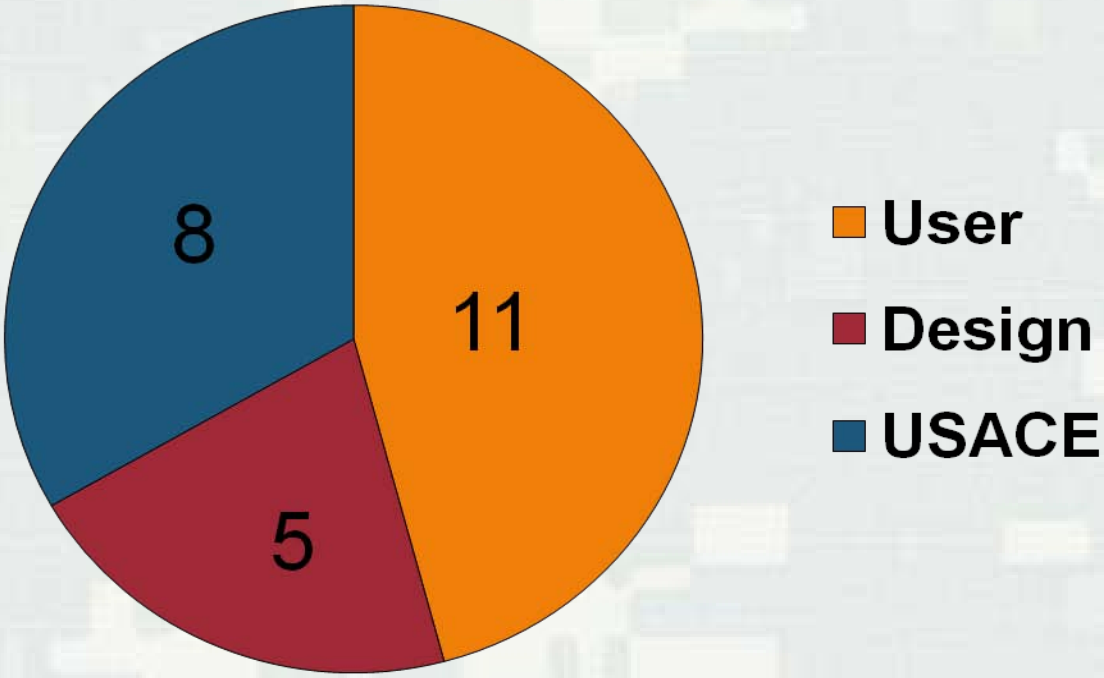
Types of Injuries



Modifications

TOTAL MODS: 24

Less than 1% Cost Growth



Effective Project Scheduling

- **Notice to Proceed provided on February 1, 2008**
- **First foundation poured during 1st week of July 2008**
- **Design / Construction completed in 24 ½ months—three months ahead of contract completion date**
  - **C3, C4, & C5 BOD*: Dec 2009**
  - **C1 & C8 BOD*: Jan 2010**
- **Total expended labor hours (not including design time) reached approximately 1.1 million…650 workers on site at one time**
- **Over 5,000 tons of structural steel erected**
- **67 Classrooms and 74 Laboratories (including NIDA, soldering, engine, and small arms repair)**

** BOD = Beneficial Occupancy Date*

Wall and Window Mock-up

Wall and Window Mock-up

Auditorium

Bullet Trap

Diesel Lab

Laser Lab

LASER
IN USE
LASER
IN USE
408
DANGER
LASER
LASER
IN USE
08/04/2010

08/04/2010

08/04/2010

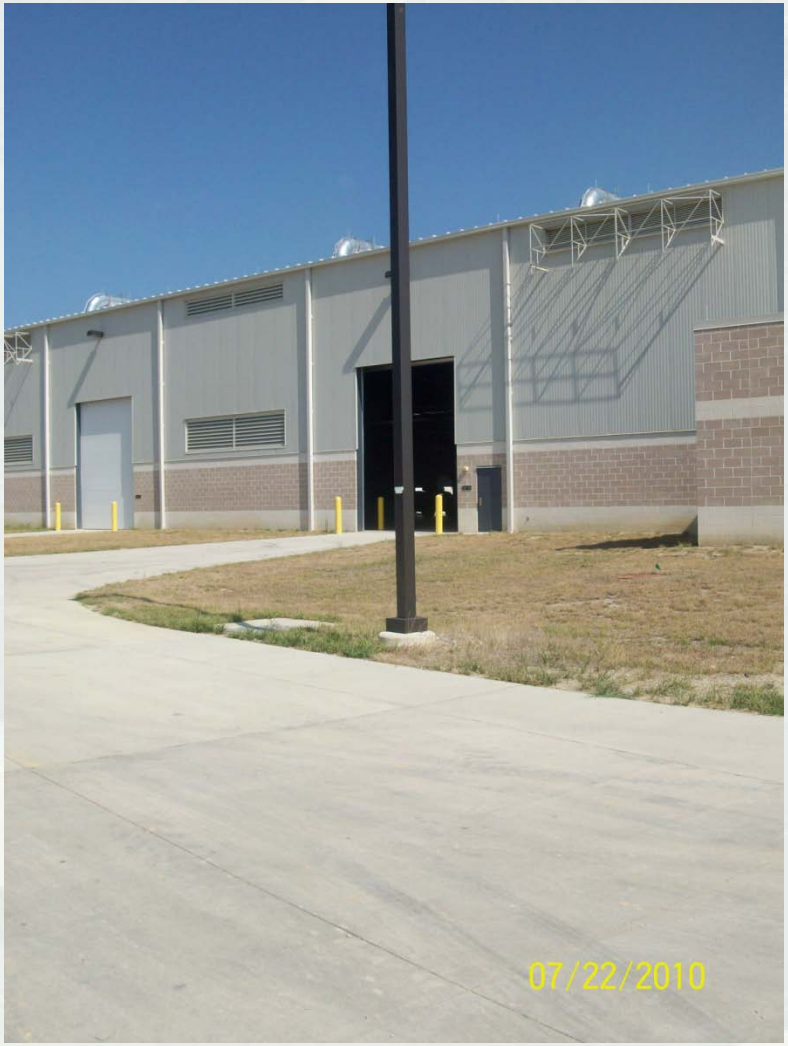
Milling

NIDA

Lessons Learned

Lessons Learned
(Light Pole Placement)

- **Make sure light poles are properly placed**
  - **Too close to road edge of pavement**



Lessons Learned

High Bay Ventilation

- **Provide vent cover to alleviate problems with leaking, snow getting sucked up into vent, and water in the building**

Lessons Learned

Electric Code

- **Water stations, such as eye wash or shower, must be a minimum of 6’ away from high-voltage areas**

Lessons Learned

Improper OH Door Track Installation

- **Restrain from welding galvanized material; it ruins galvanization and therefore must be repainted**

Lessons Learned

Proper seals **necessary to prevent** water infiltration

Lessons Learned

Inadequate Factory Paint Covering

- **Columns had to be repainted because of rust issues**

Lessons Learned

Improper Door Installation

- **Door closer ripped out of door due to improper initial installation**
  - **Needed to be bolted all the way through the door**

Lessons Learned

Properly fitting doors

- **Doors need to fit properly to ensure safe and easy operation**

Lessons Learned

Room layouts important

- **Cabinet too big and obstructs usable area in classroom**

Lessons Learned

Expansion joints

- **Properly install expansion joints so cracking does not occur and require reinstallation**

Lessons Learned

Proper light spacing

- **Added light fixtures because designed lighting did not reach some areas**

Lessons Learned

Fire Safety is key in room layout

- **Column obstructs modular furniture and creates wasted space**

WRONG

RIGHT

Lessons Learned

Wasted Space Created

Lessons Learned

Modular furniture covered windows, sections had to be removed

Lessons Learned

Seal HVAC Systems

- **Seal HVAC units for proper LEED compliance and to prevent damage to system**

Lessons Learned

- **Proper wiring for welders and equipment**

Lessons Learned

Water Infiltration due to over-tightening of rain skirts

RAIN SKIRTS

NEW SEALED BUCKETS

Lessons Learned

Hydrant too low; follow specifications and guidelines

Lessons Learned

Poor geometrics

- **Radius was too sharp; now has 50’ radius**

Lessons Learned

Building too close to road

- **Jersey barrier needed to protect building because it is not a break-away structure in the clear zone**

Lessons Learned

Vertical exhaust hoods needed for water leaks

Lessons Learned

Inadequate slope for drainage

- **Extra drains needed to be added for proper drainage**

WAVY SLOPE

EXTRA DRAIN

Lessons Learned

Proper Connection Device Needed

- **Wrong exhaust connection for M1 tanks**

Lessons Learned

Use equipment properly

- **Fan use during pollen season brings pollen into high bays**

Lessons Learned

- **Tweaked and added emergency lighting due to equipment blockage**

Lessons Learned

- **Coordinate crosswalk, lighting, and handicap ramp**

Crosswalk needs to line up with sidewalk

Lessons Learned

Aesthetic appeal

- **Gas mains on side of buildings to keep out of view**

Lessons Learned

Comply with A.D.A.

- **Sidewalks and ramps need proper slopes to comply with the ADA**

- **Redirected sidewalk to comply with code**

Lessons Learned

Roof Access

- **Slope too steep**
- **Firefighters cannot fit boots between steps; fire hazard**
- **Interpretation differences of Code requirements**

Lessons Learned

Door openings recessed for leakage issues

NOT RECESSED

RECESSED

Lessons Learned

Leaking in high bays critical to avoid

Flange to prevent water from leaking between seal

Lessons Learned

Proper Heating

- **Engine Lab design did not allow for adequate heating capacity; additional heating unit had to be installed**

Lessons Learned

Inadequate opening for vehicle access

- **Not wide enough for vehicle operations and storage; fire hydrant had to be moved**

Lessons Learned

- Ensure underground utilities markings and underslab lines are maintained throughout project.
- It was evident during blower test that air enters buildings at base of all exterior walls. All light gauge steel framing on exterior walls should be installed with caulk between wall steel stud and concrete.
- All joints in concrete (construction, expansion, control, etc.) should be caulked and sealed to prevent penetration of any foreign substances (liquid, solid, dust, etc.), especially in high bays.
- Ensure all plumbing/waste/exhaust vent lines on roof are as far as possible from HVAC air intakes.
- All roofs with HVAC equipment should have interior hatch access to roof.

Lessons Learned

- All HVAC piping valves and gauges in penthouses should be accessible, so that crews are able to perform maintenance.
- Proper use of water repellent in mortar mix.
- For wall-mounted phones, use a Leviton Telcom Type 630A 6 to meet DOIM requirements.
- Ensure grout under steel columns has correct mix and is cured properly according to specifications.
- All equipment disconnects should be accessible from the floor.