New San Francisco Federal Building Site Tour

Mark Levi, GSA - Owner
Tim Christ, Morphosis – Design Team
Jonathan Soper, Enovity – Commissioning Authority

Mark Levi

GSA PBS Pacific Rim Region

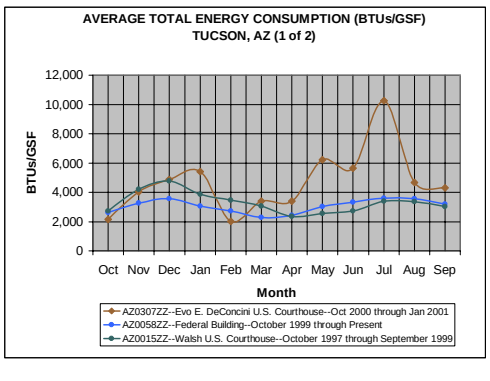
New Building Efficiency

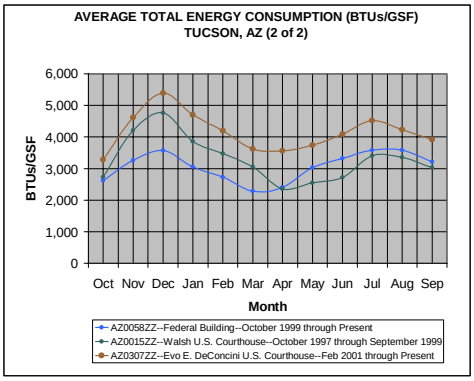
The Problem

- New courthouses underperforming courthouses from the 1960s or early 1970s in energy performance
- Performance is worst soon after completion
- Significant operational problems at time of occupancy

- Evo DeConcini U.S. Courthouse, Tucson, AZ

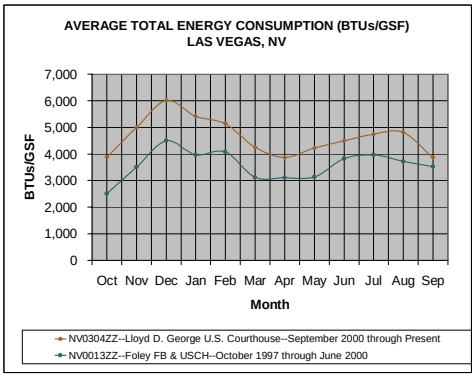
- Walsh Courthouse, Tucson, AZ





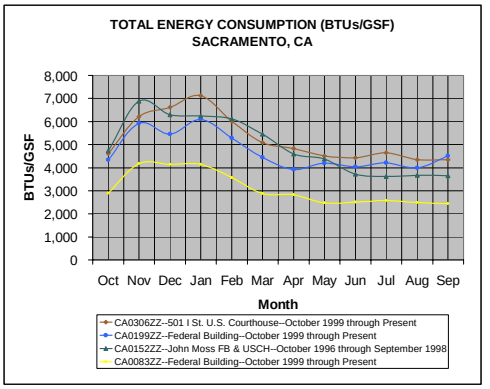
- Lloyd George Courthouse, Las Vegas, NV

- Foley Courthouse, Las Vegas, NV



- U.S. Courthouse, 501 "I" St., Sacramento, CA

- U.S. Courthouse, 650 Capitol Mall., Sacramento, CA



Size Comparison

Location	Total Building Area (GSF)	
	OLD Courthouse	NEW Courthouse
TUCSON	82,360 GSF	413,000 GSF
LAS VEGAS	201,203 GSF	454,885 GSF
SACRAMENTO	368,112 GSF	773,987 GSF

The Suspects

- Less shading, more clear glazing
- Less thermal mass
- DDC controls
- Construction QA / QC problems
- Lack of design integration (e.g. controls sequences; responsibility for envelope performance)

Systemic Design Problems

- Over-design (over-estimated loads + safety factors, not understanding load diversity)
- Not distinguishing infrastructure (worst case sizing) from programming
- Inability to handle low loads, small 24/7 loads
- Failure to fully specify sequences of operations
- Lack of systemic integration of disciplines

Systemic Construction Process Problems

- TAB quality problems
- DDC controls (programming & hardware)
- Poor envelope construction (missing insulation, leaks, holes)
- Poor ductwork installation
- No QA/QC of lighting controls (responsibility not well defined)
- Poor as-built documentation (if any)

DDC Controls – A Serious Mess

- Minimal specifications (or specs from OEM)
- No adherence to specifications
- Incomplete programming (e.g., schedules not set up, factory defaults not changed)
- Low quality LANs, workstations
- Poor skills by techs (sometimes)
- Poorly defined sequences of operation
- Process designed to fail – installer too far down food chain, too late in process, no communication with owner/designers

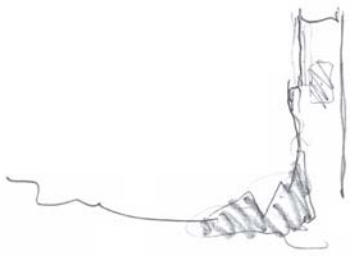
Solutions (SFFB)

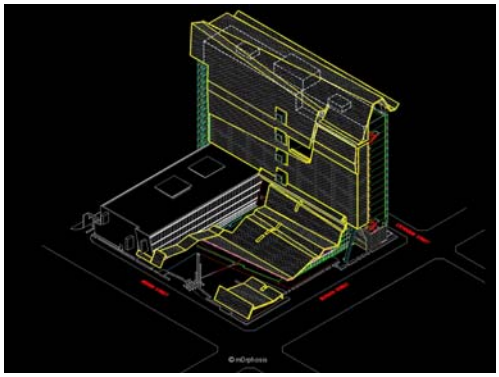
- Commissioning
- Rigorous specifications (esp. BAS)
- Design features to make up for glazing
- Aggressive review of BAS programming
- More integration of envelope with systems
- More O&M preparation before turn-over

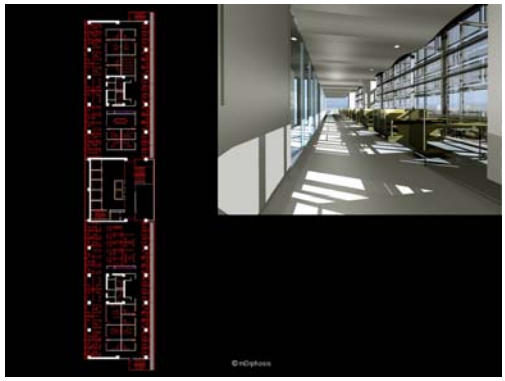
Tim Christ, Morphosis

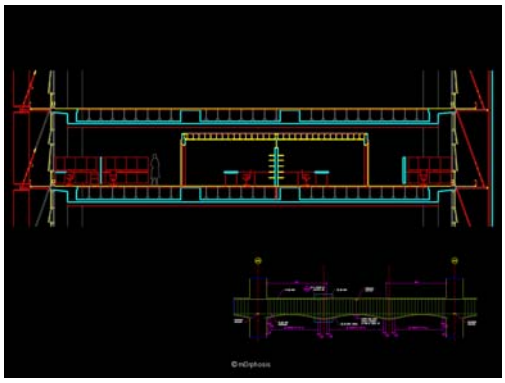
Design Team

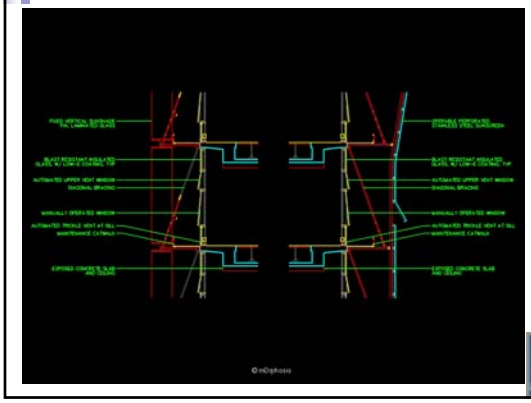
NCBC April 2006

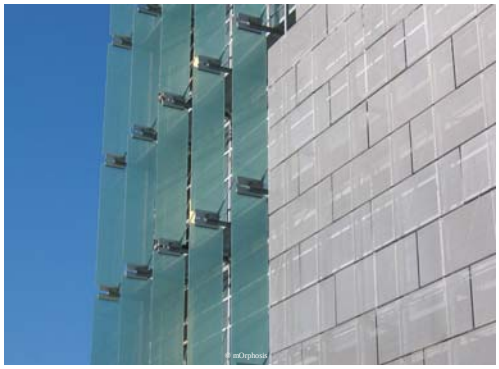






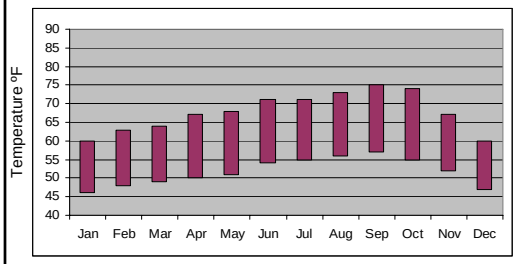






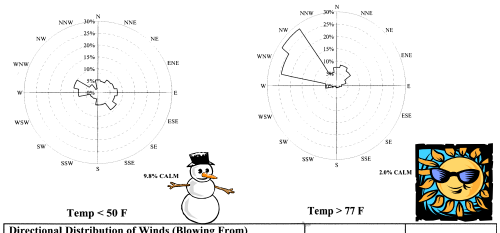
SF Outdoor Air Temperature Behavior

- Summer 1% design =78 ºF db/62 ºF wb; winter 99% design = 39ºF



- Bars show range of mean max/ mean min

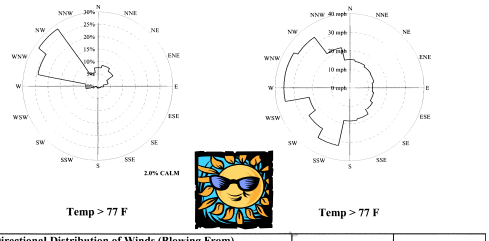
Wind climate: hot weather has prevailing NW winds



Directional Distribution of Winds (Blowing From)
San Francisco Int'l Airport, CA (1948 - 1999)
Daylight Hours (7 am to 6 pm)

New Federal Office Building - San Francisco, California | Project # 01-399 | Figure No. 7 | Date: September 5, 2001 | RWDI

Wind climate: hot weather also has high wind speed



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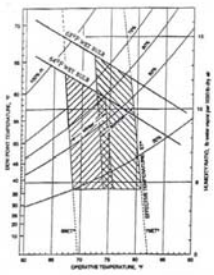
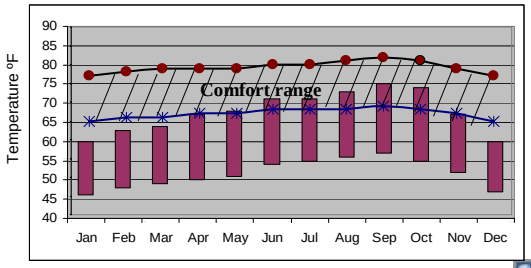
What about comfort inside?



- ASHRAE Standard 55 “specifies conditions or comfort zones here 80% of sedentary or slightly active persons find the environment thermally acceptable.”
- Based on fully air-conditioned test box laboratory tests. Results very well represent what people accept when they have no personal control over central AC.
- But what about naturally ventilated buildings around the world??

Natural ventilation comfort range superimposed on outdoor air graph



- Need internal pickup of less than 7°F

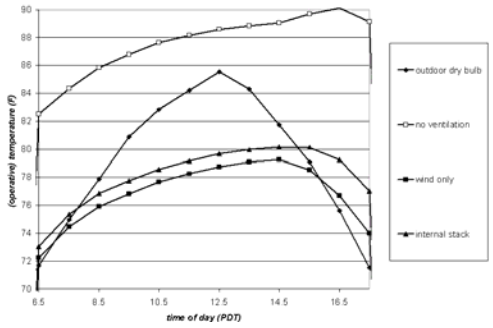
Proving the concept. . . .

Berkeley Lab

ARUP

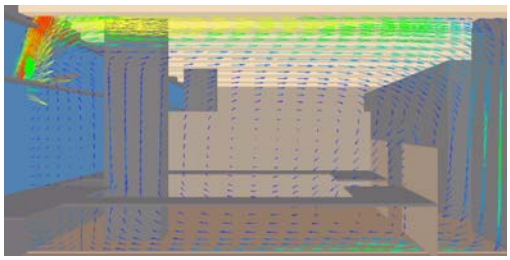
- Department of Energy software development
- Integration of COMIS and EnergyPlus (replacement of DOE2)
- Most commercially available software cannot model the dynamic heat transfer for thermal mass simultaneous to the bulk air flow for natural ventilation.

Indoor predicted behavior

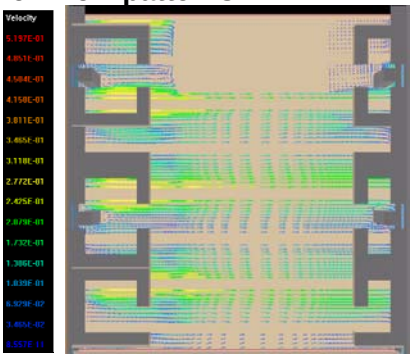


Refining the details. . . .

- Computational Fluid Dynamics confirms flow patterns above cabins

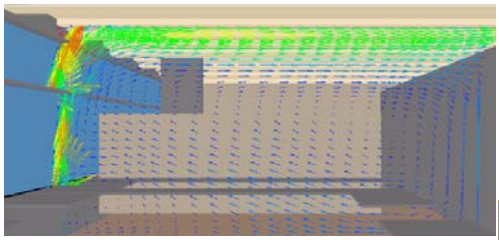


Plan view flow patterns



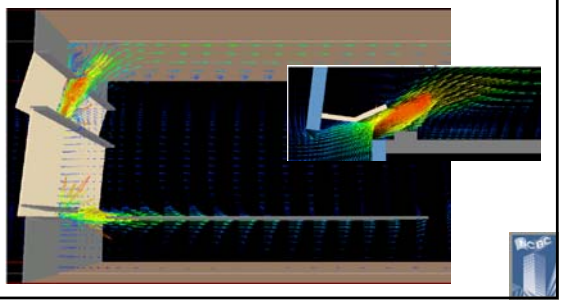
Windward people open windows . . .

- Computational Fluid Dynamics shows upward macro flow



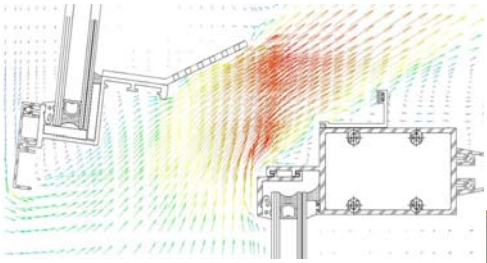
Refining the details. . . .

- Modification of window mullion/flap to direct air across NW occupied zone



Window extrusion shaped to enhance occupant feedback

- Flow deflector for bottom of user-operable window – directs main jet into occupied region



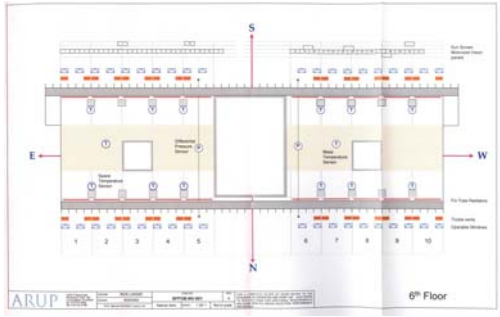
Control System Principles

- Group windows together
- Closed, half-open or fully-opened positions
- 10 opening modes
- The windward and leeward sides are identified
- Temperatures, and external pressures measured
- Each half of each floor is independently controlled
- The system responds to these variables by changing the Mode value by ±1

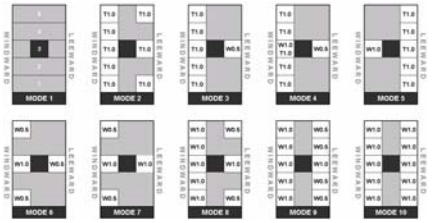
Windward – mostly user control

Leeward – building control system

Sensor Map



Schematic representation of the aperture modes

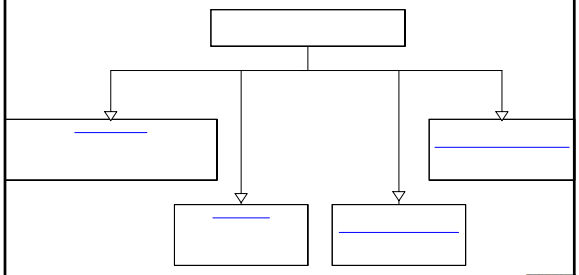


- Each floor of the building is divided into two symmetrical sides.
- The black square in the center of the figures is an elevator/service core that creates a significant obstruction to cross-ventilation airflow.

Jonathan Soper
Enovity, Inc.
Commissioning Authority

NCBC April 2006

Plan & Spec Project



Project Status

- All major electrical and HVAC equipment installed
- Building almost 100% enclosed and sealed
- Power to main distribution panels, no water
- Controls hardware and wiring 60% complete
- Equipment start-up likely begin in June
- Functional testing in late summer
- Completion and move in late 2006

Building Owner
General Services Administration

Design Team

Energy Efficient Design of Mechanical Systems by Arup

- Underfloor air distribution for air handlers serving lower floors of Tower
- Waterside economizers for heat pumps serving Tower cabins
- Primary variable flow CHW and HW distribution
- VFDs on water cooled centrifugal chillers
- Innovative sequences of operation

Scope of Commissioning Services

- LEED project with additional commissioning
- Systems to be commissioned include: HVAC and plumbing systems, BAS, natural ventilation system, lighting controls
- More focused testing on under floor air distribution systems

Commissioning Approach

- Focus on submittal reviews pertaining to control systems
- Focus on early review of control sequences programming
- Pre-functional tests will use contractor forms as basis
- Cooperation with controls contractor for functional testing
- Post occupancy tests to rely on long term trend data

Pre-functional Tests

- Debate on whether to use pre-functional test forms generated by Cx authority or contractor
- Compromise reached with a summary sign off sheet by Cx authority and contractor forms with revisions and overview by Cx authority
- Enovity to work closely with construction manager on system start-ups and inspections

Pre-functional System Readiness Form

System:	Chillers
Equipment Tag / IDs:	CH 1 & 2

System Readiness Check List:	Comments:
☐ [illegible]	
☐ [illegible]	
☐ [illegible]	
☐ [illegible]	
☐ [illegible]	
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Sign-Off:	Date:	Signature:
General Contractor		
Construction Manager		
Mechanical Contractor		
Electrical Contractor		
TAB Contractor		
Controls Contractor		
Reviewed By Cx Agent		

Functional Tests

- A lot of fairly complex sequences of operation to test
- Challenge of creating a variety of outside air and space temperature conditions during short window for functional testing
- Functional testing will likely continue over the first year of occupancy
- BAS capacity for trending will be critical

Wrap Up

Successful commissioning will require:

- **Early identification of potential system deficiencies**
- **Good cooperation and effective communication between owner, design team, contractor, construction manager and commissioning authority**