The WorkPlace 20•20 Projects Evaluation Study looked comprehensively at six different workplace projects across the U.S. Collectively, the projects represent the broader federal workplace. The projects included are:

U.S. Coast Guard MLCP(v), Oakland, CA:
This project used the WorkPlace 20•20 process and a variety of tools, including social network analysis, to support a move into a new, multi-tenant building.

GSA PBS Regional Headquarters, Chicago, IL:
The first WorkPlace 20•20 project, it used the WorkPlace 20•20 process to support a major reorganization.

U.S. Coast Guard MLCP(s), Oakland, CA:
This organization had recently reorganized into cross functional teams and leveraged the WorkPlace 20•20 process to help it realign its internal processes and work culture.
High Performance Workplace Projects

Many architects and consultants have collaborated including: Business Place Strategies, DEGW, Gensler, HOK, JHH, among others; as well universities and other researchers.

GSA FAS Regional Headquarters, Fort Worth, TX:
This project used the WorkPlace 20•20 process to support the physical consolidation and organizational integration of several groups from multiple locations into a single facility.

Veterans Administration Regional Office (VARO), Reno, NV:
This project used the WorkPlace 20•20 process to support development of a build-to-suit, single-tenant building. The VA's core values, especially the focus on serving veterans with operational efficiency and compassion, were very important planning and design criteria.

GSA PBS Customer Service Center, San Antonio, TX:
This project used the WorkPlace 20•20 process in the redesign of a customer-facing small office. The design aimed to inspire customer confidence and to support PBS’ own work needs.
Environmental variations:

- Orientation
- Open vs closed
- Interior vs core
- Zone size
- System type
CMU NEAT field instrumentation: spot & 24-hour

- records collection
- user satisfaction questionnaires (NRC COPE plus CBE)
- expert walkthrough
- technical attributes of building systems (CMU TABS)
Drawing Conclusions:
Before and After Thermal & IAQ “EKGs”

CHICAGO Thermal+IAQ EKG _ Before Renovation (36th Floor May2005)

- Temperature in work area
- Air movement in work area
- Air quality in workspace
- Temperature at 2 feet
- Temperature at floor level
- Relative humidity
- CO2 concentration
- CO concentration
- Small & large particulates
- CO2 & CO
- TVOC

Significant changes in TABS / Expert judgement of quality (1 to 7 related to thermal comfort)

1. Good diffuser alignment low quality, no diffuser
2. Fan coils at perimeter provide local control, 2-3 Marco
3. Core-based conference room: airflow sensors only
4. Some dedicated spaces no exhaust for copy/machines
5. Complaints of dust, aging materials

CHICAGO Thermal EKG _ After Renovation (33rd & 36th Floors Nov2006)

- Temperature in work area
- Air movement in work area
- Air quality in workspace
- Temperature at 4 feet
- Temperature at 2 feet
- Temperature at floor level
- Horizontal radiant temp. difference
- Vertical radiant temp. difference
- Relative humidity
- CO2 concentration
- CO concentration
- Small & large particulates
- CO2 & CO
- TVOC

Significant changes in TABS / Expert judgement of quality (1 to 7 related to thermal comfort)

1. Good diffuser alignment low quality, no diffuser
2. Furniture blockage of two coil air continues degradation of control
3. Temperature control upstairs only no readings
4. Dedicated exhaust for copy/machines in closed rooms
5. New, low VOC materials no degradation

COPE on-site satisfaction
CBE on-line satisfaction
NEAT spot measures vs. code
Airquity 24hr vs. std
“tattletales”

TABS attributes

COPE On-site Short-term Survey (% dissatisfied/un satified)
CBE Online Long-term Survey (% dissatisfied/un satified)
NEAT spot measurement (% out of within standards)
NEAT continuous measurement (% of occupied time out of within standards)
NEAT/CBE max Environmental Indicators (% of workstations)
Cross Portfolio Analyses
Subjective and Objective Measures

600 workstations
in large US office buildings

Measured: On average, spaces meet Code

Perception: 50% dissatisfied

While thermal and relative humidity conditions in federal facilities predominantly met ASHRAE comfort standards, users were 50% dissatisfied with temperature and air movement conditions.
Cross Portfolio Analyses
Subjective and Objective Measures

Measured: light levels below code

Perception: 20% dissatisfied, 80% satisfied

While light levels in federal facilities often did not meet IES lighting standards, users were 80% satisfied with light levels and quality.
7 Recommendations for Energy Savings + Performance in the GSA Portfolio (to save over 450M kWh/year)

- Electric lighting upgrades: 260 M kWh (35% retrofit rate)
- Dedicated print rooms: 55 M kWh
- Monitor upgrades: 39 M kWh
- Temperature control: 37 M kWh
- Filter management: 24 M kWh
- Daylight dominant: 19 M kWh (5% retrofit rate)
- Window upgrades: 15.8 M kWh (5% retrofit rate)
# TABS: HVAC

<table>
<thead>
<tr>
<th>System Type:</th>
<th>All Air Systems VAV</th>
<th>67%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air and Water Systems: FanCoil + CV</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>&gt;75</td>
<td>23%</td>
<td></td>
</tr>
<tr>
<td>25-75</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td>10-15</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>5-10</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>Individual Control</td>
<td>23%</td>
<td></td>
</tr>
</tbody>
</table>

### Size of Zone in Core (number of occupants per thermostat):

<table>
<thead>
<tr>
<th>(6 sites, 8 buildings, 12 workgroups)</th>
</tr>
</thead>
</table>

### Level of Control:

<table>
<thead>
<tr>
<th>(5 sites, 7 buildings, 12 workgroups)</th>
</tr>
</thead>
</table>

### Hidden thermostat (no control) | 58% |
| Locked but visible thermostat with setpoint | 8% |
| Accessible thermostat with setpoint | 8% |
| Separate thermal and ventilation control | 29% |

1. **“Raise Summer Temperature.”**

   Raise too cold indoor temperature setpoints 2°F in summer for improved comfort in summer clothing, saving 4% of total annual energy.
Measured air temperature distribution in GSA buildings reveals 40% “too cold” conditions in summer.

(In 22 federal office buildings nationwide, on 43 office floors, a statistical sample of 624 workstations)
60% of the occupants reported unsatisfactory indoor temperatures during measurements in the summer months (COPE).

"Temperature in your work area?" (summer n = 140, 15 buildings)

On-line CBE questionnaires also reported 61% of workers complaining that it is ‘too cool’ in summer.
3 “Replace Antiquated Lighting”

If only 35% of the antiquated lighting in 175 million square feet of federally owned facilities was retrofitted with high performance lighting, the energy savings would be over 260 million kWh of electric energy per year.

<table>
<thead>
<tr>
<th>Ceiling fixture type &amp; shape: (9 sites, 1 buildings, 23 workgroups)</th>
<th>2' x 2'</th>
<th>2' x 4'</th>
<th>1' x 4'</th>
</tr>
</thead>
<tbody>
<tr>
<td>2' x 2'</td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2' x 4'</td>
<td></td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>1' x 4'</td>
<td></td>
<td>26%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ceiling light lens type: (9 sites, 1 buildings, 23 workgroups)</th>
<th>Flush prismatic</th>
<th>70%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium cell parabolic</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>Large cell parabolic</td>
<td>2%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ceiling light lamps: (6 sites, 8 buildings, 15 workgroups)</th>
<th>T-12</th>
<th>T-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-12</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>T-8</td>
<td></td>
<td>60%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ceiling light lens type: (6 sites, 8 buildings, 15 workgroups)</th>
<th>Large cell parabolic</th>
<th>22%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium cell parabolic</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>T-12</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>T-8</td>
<td>60%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Identifurniture panel color: (9 sites, 1 buildings, 23 workgroups)</th>
<th>Light</th>
<th>Medium</th>
<th>Dark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>50%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>21%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark</td>
<td>29%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Typical workstation computer screens: (6 sites, 8 buildings, 10 workgroups)</th>
<th>Olddeep tube CRT DTV</th>
<th>72%</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCD with desktop processor</td>
<td>78%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fixed under bin Task Light (6 sites, 6 buildings, 16 workgroups)</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed under bin Task Light</td>
<td>1.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Installed lighting (ceiling only): (3 sites, 3 buildings, 6 workgroups)</th>
<th>Watts/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed lighting (ceiling only)</td>
<td>1.5 - 3</td>
</tr>
</tbody>
</table>
• All lighting is providing both ambient lighting and higher level task lighting from the ceiling.
• 37% of workstations also have task lighting, typically underbin.
• On average, 2.4 watts/sqft of lighting was in use.
• 30% of the lights are still T-12 with magnetic ballasts.
• 60% of the lights still do not have parabolic louvers.

Ceiling lights with flush lens

Ceiling lights with parabolic louvers

(22 federal office buildings nationwide, on 43 office floors)
- 57% of federal workstations do not have adequate light levels for paper-based tasks on primary work surfaces (>500 lux) even with task lights on.
- 43% of light levels are too high for computer based works (<500 lux).

![Light Levels on Primary Worksurface in 19 Federal Building Groups with Task Lights On](image)

(* IES (2004) recommends minimum 500 lux light levels on worksurface for paper based work)

(A statistical sample of 286 workstations were measured for light levels on primary work surfaces and screens, and user satisfaction questionnaires were distributed for comparison)
User satisfaction is highest with lower light levels for computer tasks, but reversed for paper based tasks.

- Increasing satisfaction with 500+ lux
- Decreasing satisfaction with 500+ lux

<table>
<thead>
<tr>
<th>Light Level</th>
<th>User Satisfaction Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100 lux</td>
<td>5 (n=0, 32)</td>
</tr>
<tr>
<td>100&lt;200 lux</td>
<td>4 (n=25, 109)</td>
</tr>
<tr>
<td>200&lt;300 lux</td>
<td>5 (n=51, 69)</td>
</tr>
<tr>
<td>300&lt;400 lux</td>
<td>5 (n=63, 43)</td>
</tr>
<tr>
<td>400&lt;500 lux</td>
<td>5 (n=50, 24)</td>
</tr>
<tr>
<td>500&lt;1000</td>
<td>5 (n=109, 25)</td>
</tr>
<tr>
<td>1000&lt;</td>
<td>5 (n=26, 0)</td>
</tr>
</tbody>
</table>

Q1 (Paper-based) Q11 (Glare on screen)
• Separate ambient lighting levels from task lighting to improve lighting quality and reduce energy.

• Provide ambient electric light levels of 200-300 lux for general safety and effective computer-based work.

• Provide flexible task lights for all occupants who have paper based work to enable reading fine print/low contrast paper documents.

• Incorporate daylight into the overall design strategy.
Beyond the energy benefits to separating ambient and task lighting, research reveals a number of other health and productivity benefits:

- Eliminating magnetic ballasts with potential for flickering lights and buzzing sounds can reduce headaches by 74% (Wilkins et al 1989).
- Replacing conventional downlights with direct-indirect fixtures and adding venetian blinds to windows can reduce headaches by 27% (Aaras et al 1998).
- Replacing ceiling-only combined task and ambient lighting with separate task and ambient lighting can reduce headaches by 19% (Cakir and Cakir 1998).
- Replacing parabolic louver downlights with lensed indirect lighting can improve perceived productivity by 3% (Hedge et al 1995).
- Replacing standard lensed troffers with direct-indirect lighting can improve (reading comprehension) task performance by 261% (Katzev 1992).
Provide daylighting and seated views for the maximum number of workstations for energy savings as well as employee satisfaction, health and performance.
• Stop the application of solar films that reduce daylight transmission.
• Move private offices from the window.
• Move open workstations directly to the window.
• Lower partitions that are parallel to the window.
• Introduce light redirecting blinds.
• Install switches or daylight sensors for all perimeter lighting.
• Enhance seated views.

45% of the workers in the federal facilities studied sit within 15 feet of a window.
‘Daylight harvesting’ has been shown to reduce total lighting energy in buildings by 5-50%, depending on the depth of the building/ (Verderber and Rubinstein 1984)

An average 25% reduction in lighting loads with a 5% retrofit rate for owned federal facilities would translate into an energy savings of 19 million kWh per year.
In a 1994 study of 2000 workers in DOE facilities in Washington DC, user perception of health symptoms was statistically lower among workers with seated views of windows.
### Create Dedicate Copy Rooms.

Shift from multiple distributed printers and copiers to shared copy rooms for improved collaboration without distraction, as well as for energy and paper conservation.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of occupants in open workstation</td>
<td>(8 sites, 10 buildings, 22 workgroups)</td>
<td>64%</td>
</tr>
<tr>
<td>Percent of occupants in closed office</td>
<td>(8 sites, 10 buildings, 22 workgroups)</td>
<td>36%</td>
</tr>
<tr>
<td>Typical open workstation sizes:</td>
<td>&lt;80 sf</td>
<td>63%</td>
</tr>
<tr>
<td></td>
<td>&gt;80 ft and &lt;120 ft</td>
<td>19%</td>
</tr>
<tr>
<td></td>
<td>&gt;120 ft</td>
<td>19%</td>
</tr>
<tr>
<td>Partition height (inches) &amp; number of sides per workstation:</td>
<td>1 side</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>2 sides</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>3 sides</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>3.5 sides without door</td>
<td>47%</td>
</tr>
<tr>
<td></td>
<td>4 sides with door</td>
<td>11%</td>
</tr>
<tr>
<td>Ergonomic support in typical workstation:</td>
<td>Ergonomic chair</td>
<td>52%</td>
</tr>
</tbody>
</table>

7 “Create Dedicate Copy Rooms.”
Dedicated copy / print rooms are associated with higher levels of perceived support for collaboration...

and with lower levels of perceived distraction from the work environment.

(n=308, Ying 2007)
• *In the 22 geographically distributed federal facilities, the average number of printers and copiers in the federal workplace has risen to 1 per 5 workers.*

• *Printers and copiers are predominantly in occupied and unoccupied workstations (44%) and clustered in circulation aisles (26%) rather than in dedicated rooms, either central large rooms (19%) or multiple copy rooms per floor (11%).*

• *Mean distance to a copier can be longer when shared copiers are in empty workstations (65 feet) than when copiers are in well-placed dedicated copy rooms (41 feet). Mean distance to copiers in circulation aisles is 36 feet.*
Improving efficiency and reducing density of printers saves as much as 50 kWh per employee per year, or 55 million kWh per year across the federal portfolio, with 25% paper savings and measurable improvements in distraction-free collaboration.

Calculated energy savings per year
70 kWh/person/year to 20 kWh/person/year X 1.1 million federal workers = 55 million kWh / year