T-CEPS
THE VIRTUAL WINDOW
Case study
Project Site
The Renovation Project Challenge

Repurposing Windowless Space
Renovation of Former O.R. Suite
Proposed 17 Bed ICU
The Architectural Program Constraint
Guidelines for Design and Construction of Hospital and Health Care Facilities (1996-97)

Critical Care Units 7.3.A6  Each patient bed shall have visual access, other than skylights, to the outside environment with not less than one outside window in each patient bed area.....Distance from the patient bed to the outside window shall not exceed 50 feet....When partitioned cubicles are used, patients’ view to outside windows may be through no more than two separate clear vision panels.
Floor Plan Illustrating 50 ft Constraint
Cross Section View

Bed within 50 feet of natural light source
The Clinical Challenge

References:

Prolonged hospital stays have been shown to cause a number of psychological illnesses in ICU patients including:

- Seasonal affective disorder (SAD)
- Depression
- Delirium
- Circadian rhythm sleep disorders (CRSDs)

(Marshall, 2004), (William B. Grant, 2011)
Technical-Clinical Objectives:

- **Accurately replicate natural lighting conditions**
  - To simulate diffused sunlight through a regular window, the virtual window must provide 10,000 lux to the patient, as well as illuminate the rest of the room in a similar manner to a traditional window.

- **Provide treatment for Delirium, CRSDs, and SAD**
  - Regulating melatonin production through specifically tailored light cycles can provide the same effects as exogenous melatonin on the body’s sleep cycle. (Cajochen, 2003)
Technical-Clinical Objectives:

- The prescriptive use of UV-B light to off-set reduced Vitamin D production
  - UV-B exposure has been shown to stimulate physiological mechanisms such as vitamin D production (Zasloff, 2005)

- Facilitating future clinical testing
  - Invite academic and industry research to conduct clinical trials
The Clinical Test Proposal and Request to Modify the Approved CON

- Requesting/proposing an equivalency due to physical challenges to comply with the AIA guidelines for renovation projects...without significant physical and financial hardships.

- A research project proposing “non-inferiority” to our existing ICU patient room environment (constructed in 1965) or comparing the 1996-97/2001 AIA guidelines to a proposed TVW device within each patient room environment.
Guidelines for Design and Construction of Hospital and Outpatient Facilities (1996-97)

1.5.C Equivalency

Insofar as practical, these minimum standards have been established to obtain a desired performance result. Prescriptive limitations…..describe a condition that is commonly recognized as a practical standard for normal operation…In all cases where specific limits are described, equivalent solutions will be acceptable if the authority having jurisdiction approves them as meeting the intent of these standards.

Nothing in this document shall be construed as restricting innovations that provide an equivalent level of performance with these standards in a manner other than that which is prescribed by this document, provided no other safety element or system is compromised to establish equivalency.
The Final Windowless ICU Bedroom Design

- UV B Lights + Relay mounted here
- Data Enabler behind Valence 1
- In-Room Control
- Client Computer in here. Enough Space
- Data Enabler behind Valence 2
- Virtual Window
The Virtual Window Installation

Therapeutic Cognitive Environment Psycho-Physiological System (T-CEPS)
Its Components
What the patient and staff see...
The Need for Funded Research

2134 patient days
2111 virtual window days
87 survey respondents

32.7% rated virtual window equal to normal window
21.2% rated virtual window superior to normal window
For all sad words of tongue and pen, the saddest are these, ‘It might have been’. - John Greenleaf Whittier
Other outcomes...

1.2-4 Environment of Care Requirements

1.2-4.4 Physical Environment Elements: Descriptions of and/or design criteria for the following shall be included.

**Light:** How the use and availability of natural light and illumination are to be considered in the design of the physical environment. *Includes extensive appendix language describing natural & artificial lighting strategies, including reference to ANSI/IES RP 28 and 29.*

**Views of and access to nature:** How the use and availability of views and other access to nature are to be considered in the design of the physical environment. *Includes extensive appendix language describing value of, and strategies for, access to nature elements (interior and exterior)*
1.1-6 Equivalency Concepts

Although the Guidelines is adopted as a regulatory standard by many jurisdictions, it is the intent of the document to permit and promote equivalency concepts.

Nothing in this document shall be construed as restricting innovations that provide an equivalent level of performance with these standards in a manner other than that prescribed by this document, provided no other safety element or system is compromised to establish equivalency. Extensive appendix language confirms equivalency concepts, and emphasizes such actions must be acceptable to the authority having jurisdiction.

2.1-7.2.2.5(1) Each patient room shall be provided with natural light by means of a window to the outside.

A2.1-7.2.2.5(1): A window in each patient room, the views from it, and the diurnal cycle of natural light afforded by it are important for the psychological well-being of all patients, as well as for meeting fire safety and building code requirements.

Critical Care Patient Care Areas 2.2-2.6.2.3 ....in renovation projects....use of clerestory windows equipped with glare and sun control...permitted....distance from patient bed to exterior shall not exceed 50 feet...patients’ view to exterior windows shall be through no more than two separate clear view panels.
Today’s Market Alternatives
Skyfactory™ Luminous Window

- Provides static and looped images opposed to real-time video
- Superficial in terms of simulating color temp of daylight
- Inability to prescribe LED flood lights lux to offset Vitamin D deficiency
- Inability to manage Delirium through Circadian Rhythm.
Provides a parallax experience, however constrained by the need to wear an infrared necklace. Consequently, only one person at a time can get the full visual effect.
Mayo Clinic + Delos Well Living Lab

Sensors in room (in red) to track:

- Temperature + Humidity
- Appliances
- Gas Array (VOCs, CO2, Ozone, etc.)
- Air flow
- Embedded sleep monitors