2014

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DESIGN AND CONSTRUCTION OF THE LYNCH, DICKEY & SINGLETON DENTAL CLINIC

SUSTAINABILITY DELIVERED - LOW ENERGY, MARKET RATE AND FUNCTION.

The opportunity to prototype a new low energy Passivhaus building type is a rare and unique chance to apply universal building physics to a new set of variables. This project posed the question of whether Passivhaus principles could provide for a low energy building with high process loading and inherently high interior heat gains. After one year of design and construction and a year of monitoring, the jury is in with a resoundingly positive, yes, it is not just possible, it is affordable!

Project History

Our design build firm has a rather unique regional market niche, completing 11 dental clinics in 10 years. In late 2010, we were approached by Dr. Sean Lynch, DDS, Dr. Randy Dickey, DDS and Dr. John Singleton, DDS, a group of 3 dentists with a 30 year old practice, to design and build our 12th clinic. The practice was being transitioned to a new generation and they wanted to build a 5400 ft^2 dental clinic, for their successorôs practice. We introduced the group to the idea of a first in the world low energy Passivhaus dental clinic. Passivhaus is the worldôs strictest standard for building energy performance and the most effective path to achieving net-zero energy use buildings. Unlike other green design standards, Passivhaus brings a laser-like focus on operating energy, which over the lifetime of a traditional building, quickly exceeds embodied energy (the energy used in the production and transport of construction materials and the construction process itself). At its core, Passivhaus is Physics. The principles and methods of the system are all calculation based and performance driven. Passivhaus sets target performance metrics as opposed to the more typical checklist approach to sustainability. This allows the design/build team to create a project with the only limitations being physics, creativity and budget.

Project Development

After introducing the idea of this cutting edge low energy clinic to the group, their answer came back that if it made financial sense they would commit to this unique project. Together, we embarked on a path of discovery. During the initial design studies for the clinic, we simultaneously spent 2 ½ months gathering real time data on the existing equipmentôs energy usage. This opportunity was very fortunate for the team, as this type of real world data is hard to come by. When one lacks this type of real world information one has to depend on the plate rated energy usage of the equipment for energy models. This can make accurate prediction of energy use more difficult.

Once the design and monitoring was complete, we calculated energy models of both a standard code built building and the proposed Passivhaus building. Our results showed that the Passivhaus building would use approximately 75% less heating and cooling energy and an impressive 50% less overall energy then if the clinic was built to the current energy code requirements!

The last piece of the puzzle we needed for the groupôs decision was a cost figure. With our track record of dental clinic design/build, we had very accurate real time cost information for dental clinics. Our experience is that in our region the typical delivered cost for a new dental clinic is between \$150/ft^2 and \$200/ft^2. The new Passivhaus dental

clinic came in at $155/ft^2! With a market rate delivery price at the low end of the scale and an energy savings of 50%, this became an easy decision for the group.

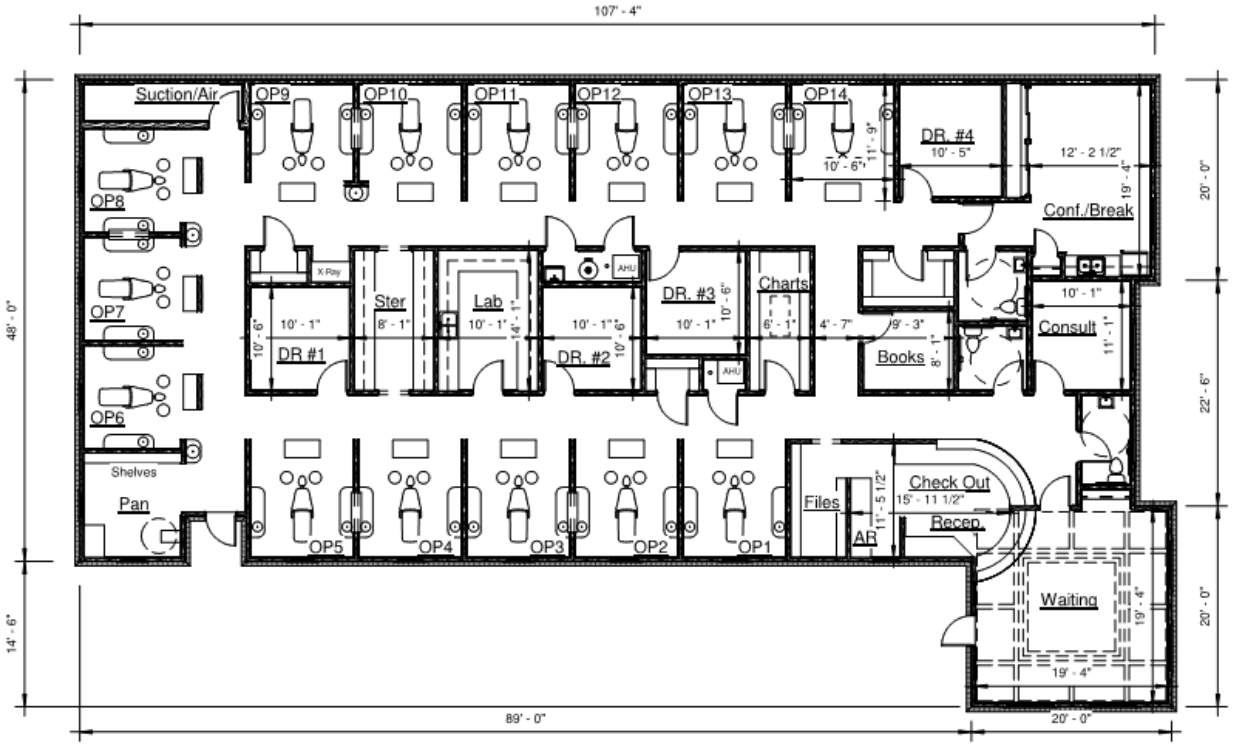

Figure 1 - Clinic floor plan

Passivhaus Mechanical Design and Dental use

Figure 2 - Passive Radiant Cooling Rough-in

As we completed our analysis we also found that not only did it make financial sense; the interior comfort and air quality would be significantly better in a Passivhaus clinic. Our firmós familiarity with the issues specifically associated with dental clinic design and construction lead us to address the following issue: A consistent area of concern in all clinics is the thermal comfort of the doctor and patient. Doctors generally complain of being too hot and often patients complain of being too cold. It was not until we completed the Passivhaus building analysis of this project that the reasons became crystal clear. When one has a dental procedure

taking place, one typically has a nervous patient, a working doctor, an assistant and a dental light. When calculating the heat load in the small work area it becomes clear that the heat generated by the people and light is significant. To overcome the comfort issue of the client (the dentist) a typical solution is to introduce a large amount of high velocity conditioned air in the area behind the chair to keep the dentist and assistant cool. Unfortunately, this has the unintended consequence of making the stationary and potentially nervous patient cold as the conditioned air causes the perspiration of the patient to evaporate making them cold.

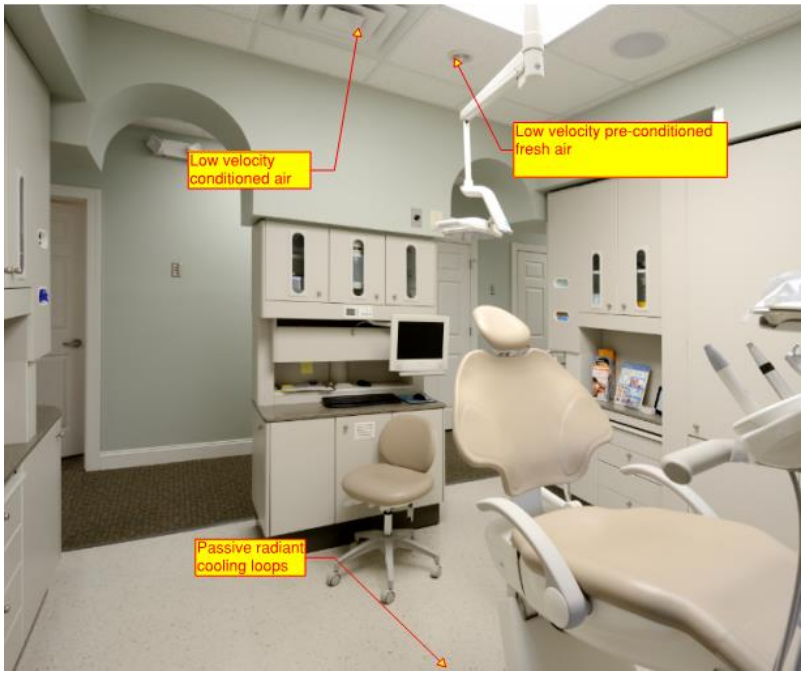

Figure 3 - Operatory comfort strategy

To overcome the comfort issue of doctor and patient we designed a multi-pronged approach. We introduced pre-conditioned fresh air along the ceiling of each operatory space at a very low velocity; we then installed a separate low velocity forced air conditioning system directed behind the dental chair. By designing the ductwork and diffusers for low velocity, the conditioned air slowly drops out of the register reducing the evaporation of the patientôs perspiration, increasing the patientôs comfort. Lastly, we installed 100 ft^2 passive radiant cooling loops in the floor around each dental chair to take radiant heat from the dentist and assistant, while leaving the patient comfortable with the chair acting as an insulated barrier to the radiative cooling in the floor. The doctors report that the operatory thermal comfort is exceptional.

There is also a synergistic interaction between some of the principles of Passivhaus and the dental clinic building type, which makes it exceptionally well suited for the Passivhaus construction. Passivhaus is a fabric first approach to building energy use, meaning it focuses on the building envelope first to reduce loads on the building systems. It does this through the combination of robust and clever superinsulation, exceptional windows and doors and air tight construction. The reduction of air infiltration and exfiltration through the building envelope results in up to a 50% reduction in heating and cooling

loads and this reduces the size and cost of the mechanical system. As one tightens up the building envelope, there is a need to bring in fresh air, not because a ñbuilding needs to breatheò as I hear so often, but because the occupants of a building need to breathe. For this fresh air intake, we use state of the art Energy Recovery Ventilators that bring in a constant supply of filtered fresh air. These ventilators provide both energy savings by recovering energy in the exhaust air stream and comfort by balancing humidity and filtering the air coming in. One of the items about this clinic that is most mentioned by patients is that the fresh air exchange has eliminated the ñdental clinic smellò

First Year Results

We have been monitoring the total energy usage of the clinic for one full year. After 12 months, the buildings energy use is an incredible 2.5% below that predicted! The combination of our ability to set up energy monitoring on the existing dental equipment prior to running our models, the very consistent occupant usage of the dental practice, the robust nature of the Passivhaus methodology and our experience, made predicting the energy use fairly straight forward.

An important aspect of defining a low energy building is understanding the benchmark against which it is being judged. In North America, a typical metric by which we measure energy use is called Energy Use Intensity (EUI), which is a measure of the total energy used per ft^2 of the building expressed in thousand BTU/ft^2. Currently the best data available on existing buildings comes from the Commercial Buildings Energy Consumption Survey (CBECS) in the United States and the Commercial and Institutional Building Energy Use Survey (CIBEUS) in Canada. Because there is not a specific building type for dental clinics, the EUI for dental clinics must be extrapolated from the data sets. The following chart demonstrates that dramatic energy savings can be achieved at market rate in today.

	Passivhaus Dental Clinic - Calculated	Passivhaus Dental Clinic - Measured Results	2009 International Energy Code [1]	CEBECS Average (United States) [2]	CIBEUS Average (Canada) [3]
$kBTU/ft^2$	27.55	26.86	53.4	81.49	88.94
% Difference vs Measured Results	2.50%		49.70%	67.04%	69.80%
% Difference vs Calculated Results		-2.50%	48.41%	66.19%	69.02%

1. Energy code EUI was derived by modeling the as built design with current code requirements.
2. CEBECS EUI was extrapolated by averaging data for the following CEBECS data sets:
    a. Building square footage: 5,001-10,000

   b. Principal building activity: Healthcare – Outpatient
   c. Principal building activity: Office
   d. Year Constructed: 2000-2003
   e. Census Region and Division: South Atlantic
   f. Climate Zone: 30-Year Average: 4,000-5,499 HDD
   g. Number of Floors: One
3. CIBEUS EUI was extrapolated by averaging data for the following CIBEUS data sets:
   a. Ambulatory Surgical Center
   b. Medical Office
   c. Outpatient Rehabilitation/Physical Therapy
   d. Urgent Care/Clinic/Other Outpatient

Conclusion

Completed in January 2013, the new Dental Clinic for Drs. Lynch, Dickey and Singleton in Roanoke, Virginia has been a great success in demonstrating market rate delivery of a high performance, low energy dental clinic.

Acknowledgements

We would thank: This project was made possible by Dr. Sean Lynch, DDS, Dr. Randy Dickey, DDS and Dr. John Singleton, DDS.

Figure 4 - Grand opening