Des Moines Area Community College
West Campus

Located in the fastest-growing residential and commercial area in Iowa, the new **Des Moines Area Community College (DMACC) West Campus** is definitely enjoyed by students and faculty alike. Created on a 7.2 million dollar budget, this nearly wireless and paperless high-technology campus opened its doors in October 2001, and features high-tech classrooms, computer labs, an auditorium, and private faculty offices. The 56,000 square foot building offers innovative classrooms in which students are offered handheld computers or PDA's for classroom learning and instructional delivery, e-mail, multimedia, including the use of MP3's and video, as well as web surfing. The classrooms also allow instructors to make notes on Smart Boards at the front of the room while they instruct, and then print those notes out for the students at the end of each session. The high quality of technology readily available to students mirrors the level of interest it generates in the students, as the courses and degrees offered include IT/Network Administration, Information Technology, Business Information Systems, and more.

One of the most innovative designs lies beneath the classroom floors. A raised floor system was installed to allow power and telecommunication cords to be easily accessible from any area of the room. This allows flexibility in room layout and creates a clean appearance and a safer environment. To make use of the raised floor and to eliminate ductwork in the classrooms, an under-floor air distribution system was implemented for heating and cooling of these rooms.

As West Des Moines grows and DMACC's enrollment increases, the new West Campus will no doubt see a surge in popularity. Therefore, a modular mechanical system was designed to easily allow the building to expand to 125,000 square feet, should the need present itself.

Energy Efficiency

West Campus incorporates a geothermal water source heat pump system utilizing the four-acre pond that rests on the campus's foreground. Figure 2 is a schematic diagram illustrating the prominent features of the building's geothermal system. The pond currently provides 168 tons of cooling and is capable of providing 420 tons of cooling for future expansion. This system captures and dissipates heat from the pond and provides an energy efficient and cost-effective means of heating and cooling the entire facility.

Energy recovery ventilators (ERV's) were installed to recover sensible and latent cooling that is exhausted from the building in the summer and to recapture otherwise expelled heat in the winter. These units transfer 75% of the exhaust airstream's energy to the incoming building ventilation air. The direct digital control (DDC) building automation system also helps to minimize energy use throughout the facility by operating the HVAC system in an optimum energy efficient manner. The DDC system utilizes occupancy sensors and carbon dioxide sensors to allow a reduction in ventilation air when areas of the building are not occupied. Each ERV serves 6 rooms, each of which is served by its own heat pump. If all 6 rooms are unoccupied, the ERV is turned off, while others throughout the building may still operate as required to introduce outside air. ERV's are also controlled by a time schedule. These sequences reduce the amount of energy required to move, heat, and cool outside air.

The heat pump compressors are 2-stage with cooling EER of 13.1 and an average heating COP of 3.5. Heat pump fans are 3-speed. During unoccupied mode, heat pumps are off unless heating or cooling is necessary. During occupied mode, heat pump fans operate at medium speed, while the first compressor stage is active. As greater capacity is required in response to space temperature, fans switch to high speed and compressors utilize their second stages.

Circulating pumps are controlled by variable speed drives to reduce energy use when the building is operating at less than peak cooling or heating. Daylight harvesting was used to help ease lighting energy costs. Through the use of daylight sensors and occupancy sensors, the lighting is dimmed or turned off depending on the availability of natural day lighting.

The geothermal system, in addition to the other energy saving features of this building, resulted in a tremendous reduction of energy costs compared to those of a typical building. Modeling based on actual building construction, lighting, internal heat gains, and utility rates revealed that the energy efficient strategies associated with the HVAC system alone have contributed greatly to savings in energy costs over a design that would have employed typical constant volume package rooftop air conditioning units (RTU's) with reheat. Rooftop units were a low-first-cost option considered until estimated energy costs showed it to be cost prohibitive. Figure 1 compares predicted energy costs over a 12-month period to those obtained from the owner's utility bills, which are listed in Table 1. Predicted costs were derived by modeling the actual West Campus building and by modeling the building if RTU's had been used in place of the geothermal system. While predicted costs for the actual building vary slightly from billed values on a monthly basis, the 12-month total for each was approximately $51,000, or $0.91 per square foot. The predicted 12-month total electricity cost for the building with RTU's was just over $89,000, or $1.59 per square foot. The HVAC system installed in the building, therefore, reduced the energy costs associated with operating the DMACC West Campus facility by 43%.

Data logged while the building was in use suggested that occupancy sensors reduced lighting energy consumption by 50% in areas in which the sensors were present. It was also reported that the dimming daylighting system was operating as anticipated, further cutting energy costs.

Figure 1 - Monthly Energy Cost Comparison

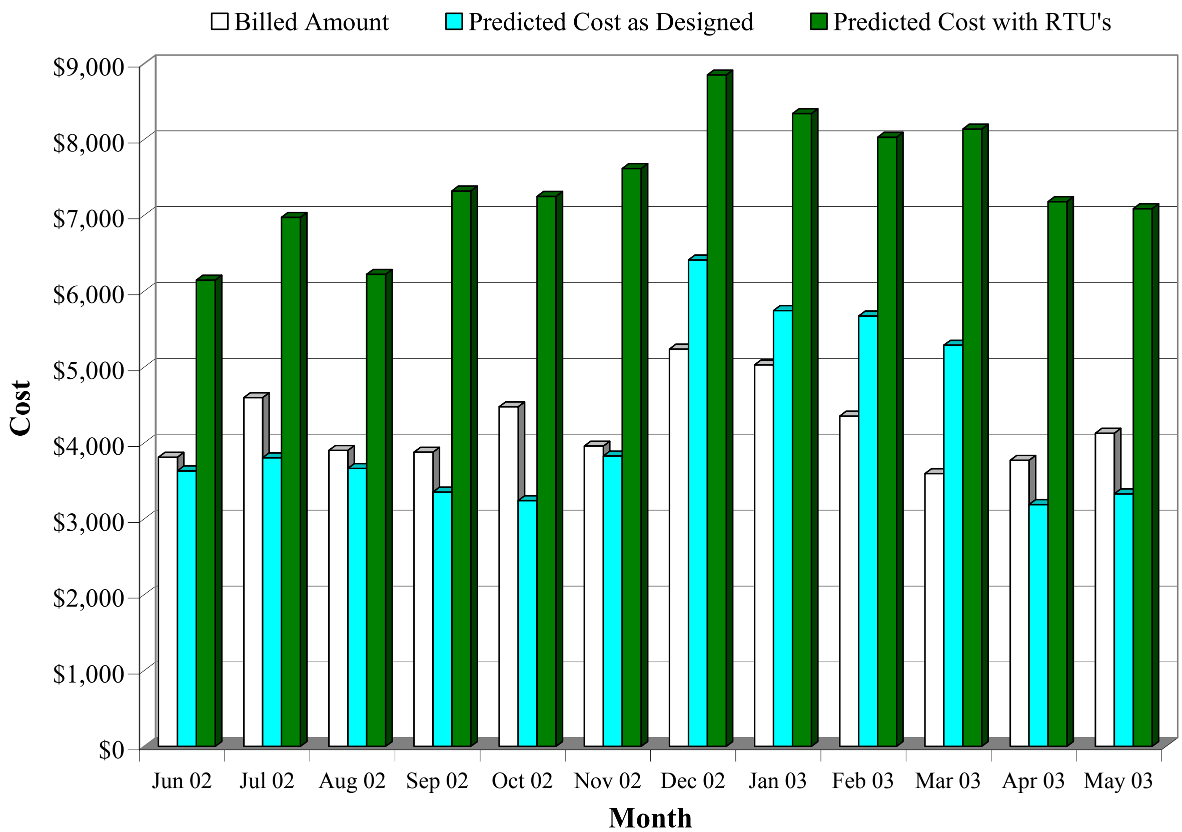

Table 1 - West Campus Utility Bill Data

Month/Year	Billed kWh	Actual kW	Amount Billed
June 2002	71,250	203	$3,810
July 2002	87,000	218	$4,596
August 2002	71,250	237	$3,900
September 2002	78,000	210	$3,878
October 2002	92,250	237	$4,476
November 2002	77,250	223	$3,957
December 2002	106,500	285	$5,236
January 2003	95,250	298	$5,027
February 2003	78,750	269	$4,351
March 2003	70,500	195	$3,595
April 2003	63,750	154	$3,771
May 2003	76,500	190	$4,126

Indoor Air Quality

Excellent indoor air quality is maintained throughout the building by using energy recovery ventilators. Ventilation air is supplied to all occupied areas of the building at rates of 15 cfm/person in classrooms and 20 cfm/person in offices, in accordance with ASHRAE Standard 62-1999 “Ventilation for Acceptable Indoor Air Quality”. A carbon dioxide sensor is installed in the auditorium to ensure the proper amount of ventilation air is supplied to the room, maintaining the recommended levels of carbon dioxide. Filters are installed in the energy recovery ventilators and heat pumps to provide clean air to the building’s occupants. Superior ventilation effectiveness is achieved by supplying fresh air from the floor at the occupants breathing zone.

Innovation

An under-floor air distribution system was installed in the flexible classrooms that have a 12-inch high raised floor system. Each classroom has a downflow heat pump that supplies air to the sealed plenum below the floor. This system utilizes variable air volume floor diffusers that are easily relocated and adjusted as necessary to accommodate furniture changes in the room. Fan-powered boxes with heating coils, which are controlled by independent thermostats, provide perimeter heating during occupied mode only (or as backup should a heat pump fail) to maintain a comfortable space temperature throughout the room. Several spaces have ceilings as high as 25 feet. But since air is supplied low and returned high, the occupied zone is properly conditioned, and the effects of stratification go unnoticed. Energy is also conserved because there is no need to move air down in these large spaces.

An in-floor radiant heating system utilizing heating water supplied by water-to-water heat pumps was installed in the concrete floor of the commons area and vestibules. This provides warmth and comfort at the floor of these high ceiling areas without requiring exposed perimeter-heating equipment. Several occupants have commented that the building interior climate remains consistent and comfortable during all weather conditions.

Operation & Maintenance

The estimated O&M cost of the installed system was $4,100, which was slightly greater than that of an RTU system, but less than that of a boiler/cooling tower heat pump system. The heat pump system is modular, so maintenance can be performed in one area of the building without interrupting cooling or heating elsewhere. Each classroom is served by a dedicated heat pump located in a mechanical room, which is accessible from the corridor. This allows workers to change filters, practically the only routine maintenance required, without disrupting classroom activities. All maintenance of HVAC equipment can be performed comfortably within the building. Since a pond is used for the heat source and heat rejection of the heat pump system, there are no boilers or cooling towers. This greatly reduces the maintenance requirements of the building and eliminates the chemical treatment associated with boilers and cooling towers. Energy recovery ventilators normally require only routine filter changes, but the energy wheel slides easily out of the machine should cleaning become necessary. The DDC building automation system's remote monitoring capabilities allow service personnel to be notified of system alarms through wireless pagers.

Cost Effectiveness

DMACC received an $88,000 construction incentive rebate from MidAmerican Energy. This rebate was based on the energy saving measures that were implemented in the design of this facility, including the geothermal heat pump system and energy recovery ventilators, as well as the high efficiency glass, occupancy sensors, daylighting, and other energy efficient strategies.

Approximately $53,600 of the rebate was attributed to energy savings due to the HVAC system. With floor-to-roof glass along the entire southern exposure of the building, this fenestration was optimized using a low-e tinted and fritted glass installed at an angle to reduce the solar load and associated cooling requirements. A 25-year life cycle cost analysis comparing a boiler/tower heat pump system and the installed geothermal heat pump system to a code minimum rooftop unit system was performed using models of actual building construction. The life cycle is based on mechanical equipment, operation and maintenance, energy, and replacement costs over a 25-year period. Results show that the geothermal heat pump system has a simple payback period of 2 years and saves $574,324 over the rooftop unit system. See Table 2 below.

Table 2 - Mechanical System Cost Comparison

	BASE RTU's	ALT 1 Boiler/Tower Heat Pumps	ALT 2 Geothermal Heat Pumps
Initial Mechanical Cost	$1,094,000	$1,122,000	$1,167,400
Annual Energy Cost	$89,000	$85,600	$51,000
Annual O&M Cost	$3,600	$4,800	$4,100
Simple Payback Years	-	12.7	***2.0***
Total Life Cycle Cost	$2,678,376	$2,367,141	$2,104,052
Life Cycle Cost Savings	-	$311,235	***$574,324***

Environmental Impact

West Campus utilizes a pond for heating and cooling which is a clean renewable energy source. The building does not have boilers or cooling towers that would produces harmful emissions to the air or require chemical treatment that would be discharged to the drainage system. In addition, no equipment is located outside, which eliminates noise pollution while improving the building’s inherent aesthetic beauty.

DMACC
WEST CAMPUS

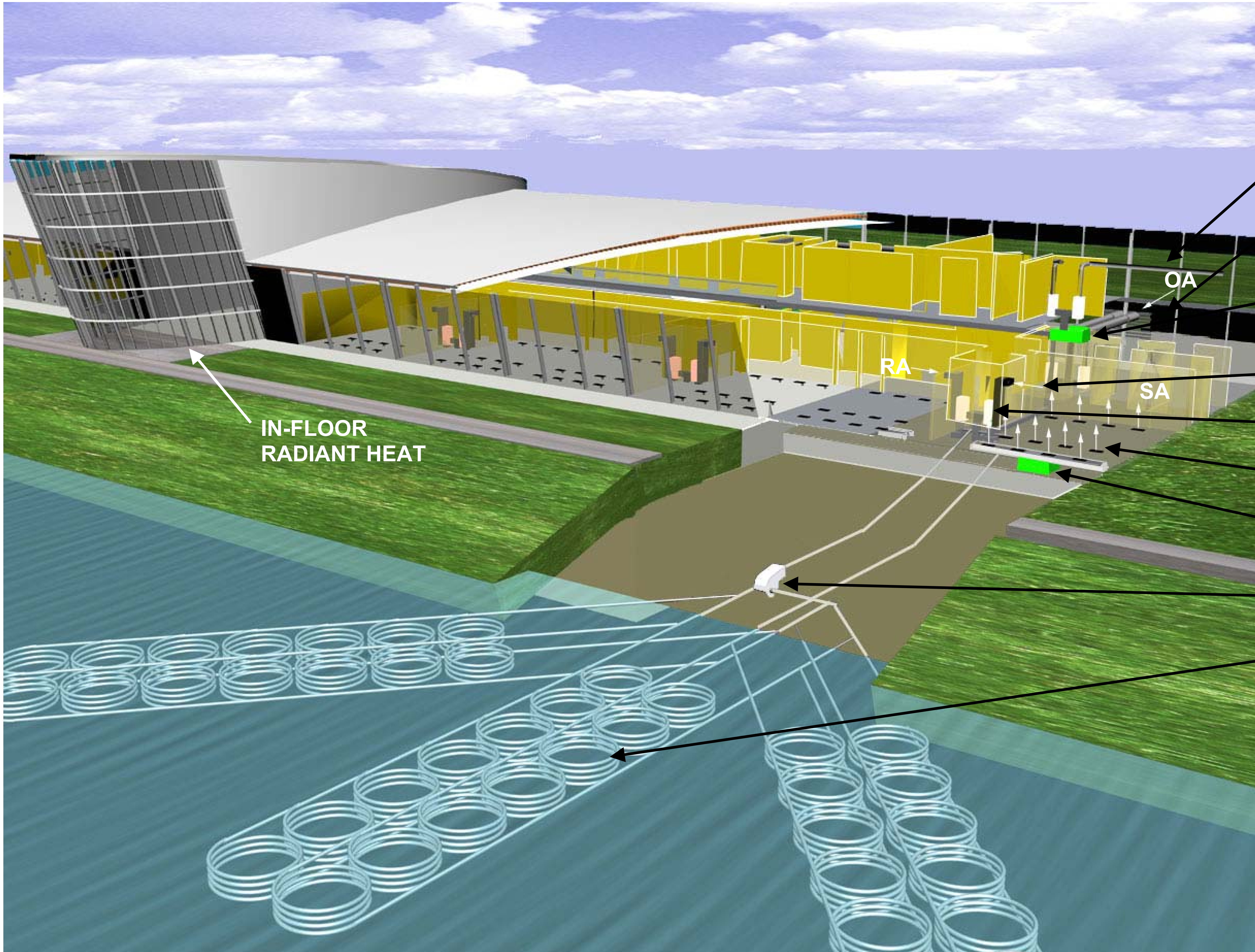

FIGURE 2 – SCHEMATIC DIAGRAM