

The Authoritative Source for Plumbing, Hydronics, Fire Protection and PVF

Plumbing Engineer®

A TMB Publication

January 2010

Follow us on twitter for
updates and news



twitter.com/plumbingeng

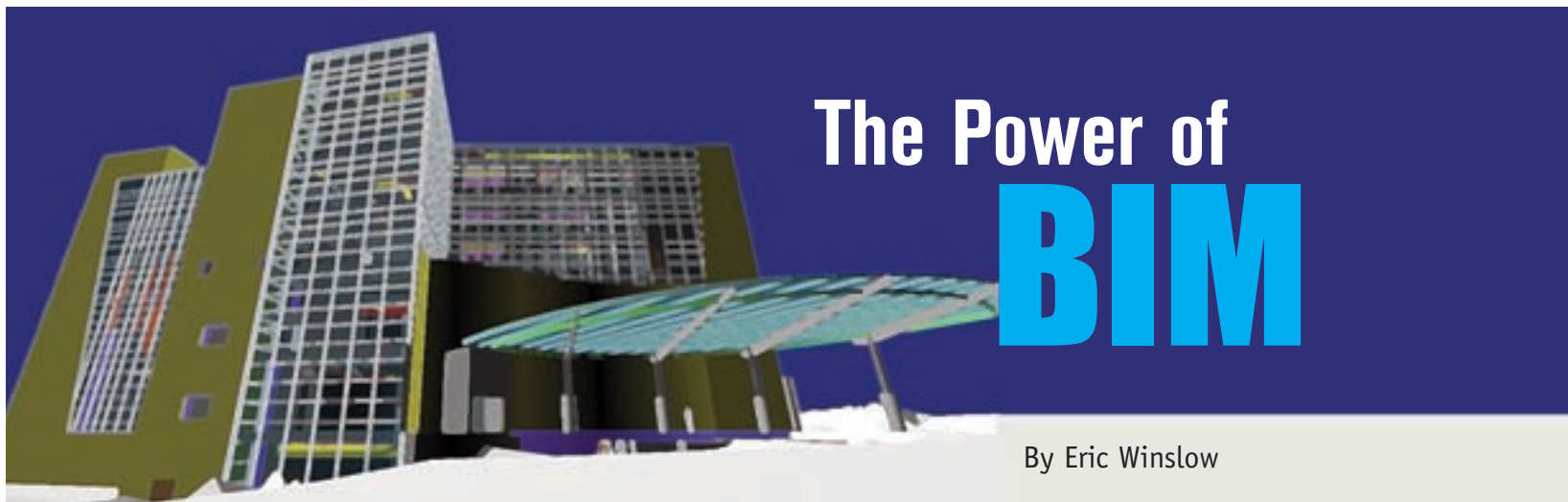


The Power of BIM



Also Inside...

- 2010 Industry Forecast
- Integrated Heat Pump Water Heaters
- Innovation Within: A look at the innovation inside a wind manufacturing plant



By Eric Winslow

The history of CAD/CAM technology in the HVAC industry stretches back to the late '70s and early '80s when we began to see the first patents issued for transferring data into machine code derived from three-dimensional objects. This technology was a substantial improvement for automating the manufacture of sheet metal ductwork as prior to this it had to be painstaking laid out by hand. Following the timeline of these innovations we witnessed new software and machinery developments, which further automated the design & fabrication of HVAC systems through the use of CAD/CAM technology. By the mid-to-late '90s, this technology was commonplace in the HVAC industry and other industries — such as structural steel companies — were adopting similar methods.

projects. Having the ability to simulate the physical features of a building in both 2D and 3D, we could now develop very precise routing of the HVAC with objects that contained all of the information required to manufacture the various components. Moving forward with greater confidence that these systems would work opened up many more opportunities for pre-fabrication, pre-purchasing and improved planning. These opportunities would often net a noticeable decrease in field labor, overall increase in productivity, all while increasing the quality of the end product. This was just the beginning.

By now most people in the construction industry are aware of the movement toward Building Information Modeling (BIM). While CAD technology, including 3D

United States Patent [11] **Patent Number:** 4,554,635
Levine [12] **Date of Patent:** Nov. 19, 1985

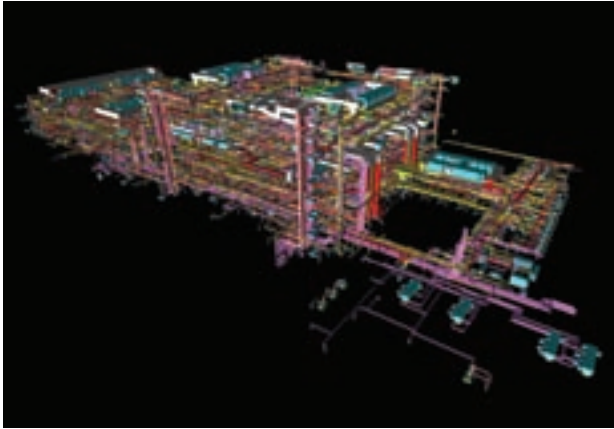
[13] **METHOD AND APPARATUS FOR MARKING OR CUTTING LAMINAR PATTERNS OR FORMS**
Primary Examiner—Joseph Veggione
Attorney, Agents or Firm—Kempner & Knapp

[14] **Inventor:** Richard W. Levine, Dobbs Ferry, N.Y.
[15] **Assignee:** Constructive Technology, Inc., Dobbs Ferry, N.Y.
[16] **Appl. No.:** 802,699
[17] **Filed:** Jan. 13, 1983

Related U.S. Application Data
[18] **Continuation-in-part of** Ser. No. 802,607, **filed** Jan. 28, 1983, **abandoned**
[19] **Int. Cl.:** G01B 11/00
[20] **U.S. Cl.:** 359/475, 359/476, 359/477, 359/478, 359/479, 359/480, 359/481, 359/482, 359/483, 359/484, 359/485, 359/486, 359/487, 359/488, 359/489, 359/490, 359/491, 359/492, 359/493, 359/494, 359/495, 359/496, 359/497, 359/498, 359/499, 359/500, 359/501, 359/502, 359/503, 359/504, 359/505, 359/506, 359/507, 359/508, 359/509, 359/510, 359/511, 359/512, 359/513, 359/514, 359/515, 359/516, 359/517, 359/518, 359/519, 359/520, 359/521, 359/522, 359/523, 359/524, 359/525, 359/526, 359/527, 359/528, 359/529, 359/530, 359/531, 359/532, 359/533, 359/534, 359/535, 359/536, 359/537, 359/538, 359/539, 359/540, 359/541, 359/542, 359/543, 359/544, 359/545, 359/546, 359/547, 359/548, 359/549, 359/550, 359/551, 359/552, 359/553, 359/554, 359/555, 359/556, 359/557, 359/558, 359/559, 359/560, 359/561, 359/562, 359/563, 359/564, 359/565, 359/566, 359/567, 359/568, 359/569, 359/570, 359/571, 359/572, 359/573, 359/574, 359/575, 359/576, 359/577, 359/578, 359/579, 359/580, 359/581, 359/582, 359/583, 359/584, 359/585, 359/586, 359/587, 359/588, 359/589, 359/590, 359/591, 359/592, 359/593, 359/594, 359/595, 359/596, 359/597, 359/598, 359/599, 359/600, 359/601, 359/602, 359/603, 359/604, 359/605, 359/606, 359/607, 359/608, 359/609, 359/610, 359/611, 359/612, 359/613, 359/614, 359/615, 359/616, 359/617, 359/618, 359/619, 359/620, 359/621, 359/622, 359/623, 359/624, 359/625, 359/626, 359/627, 359/628, 359/629, 359/630, 359/631, 359/632, 359/633, 359/634, 359/635, 359/636, 359/637, 359/638, 359/639, 359/640, 359/641, 359/642, 359/643, 359/644, 359/645, 359/646, 359/647, 359/648, 359/649, 359/650, 359/651, 359/652, 359/653, 359/654, 359/655, 359/656, 359/657, 359/658, 359/659, 359/660, 359/661, 359/662, 359/663, 359/664, 359/665, 359/666, 359/667, 359/668, 359/669, 359/670, 359/671, 359/672, 359/673, 359/674, 359/675, 359/676, 359/677, 359/678, 359/679, 359/680, 359/681, 359/682, 359/683, 359/684, 359/685, 359/686, 359/687, 359/688, 359/689, 359/690, 359/691, 359/692, 359/693, 359/694, 359/695, 359/696, 359/697, 359/698, 359/699, 359/700, 359/701, 359/702, 359/703, 359/704, 359/705, 359/706, 359/707, 359/708, 359/709, 359/710, 359/711, 359/712, 359/713, 359/714, 359/715, 359/716, 359/717, 359/718, 359/719, 359/720, 359/721, 359/722, 359/723, 359/724, 359/725, 359/726, 359/727, 359/728, 359/729, 359/730, 359/731, 359/732, 359/733, 359/734, 359/735, 359/736, 359/737, 359/738, 359/739, 359/740, 359/741, 359/742, 359/743, 359/744, 359/745, 359/746, 359/747, 359/748, 359/749, 359/750, 359/751, 359/752, 359/753, 359/754, 359/755, 359/756, 359/757, 359/758, 359/759, 359/760, 359/761, 359/762, 359/763, 359/764, 359/765, 359/766, 359/767, 359/768, 359/769, 359/770, 359/771, 359/772, 359/773, 359/774, 359/775, 359/776, 359/777, 359/778, 359/779, 359/780, 359/781, 359/782, 359/783, 359/784, 359/785, 359/786, 359/787, 359/788, 359/789, 359/790, 359/791, 359/792, 359/793, 359/794, 359/795, 359/796, 359/797, 359/798, 359/799, 359/800, 359/801, 359/802, 359/803, 359/804, 359/805, 359/806, 359/807, 359/808, 359/809, 359/810, 359/811, 359/812, 359/813, 359/814, 359/815, 359/816, 359/817, 359/818, 359/819, 359/820, 359/821, 359/822, 359/823, 359/824, 359/825, 359/826, 359/827, 359/828, 359/829, 359/830, 359/831, 359/832, 359/833, 359/834, 359/835, 359/836, 359/837, 359/838, 359/839, 359/840, 359/841, 359/842, 359/843, 359/844, 359/845, 359/846, 359/847, 359/848, 359/849, 359/850, 359/851, 359/852, 359/853, 359/854, 359/855, 359/856, 359/857, 359/858, 359/859, 359/860, 359/861, 359/862, 359/863, 359/864, 359/865, 359/866, 359/867, 359/868, 359/869, 359/870, 359/871, 359/872, 359/873, 359/874, 359/875, 359/876, 359/877, 359/878, 359/879, 359/880, 359/881, 359/882, 359/883, 359/884, 359/885, 359/886, 359/887, 359/888, 359/889, 359/890, 359/891, 359/892, 359/893, 359/894, 359/895, 359/896, 359/897, 359/898, 359/899, 359/900, 359/901, 359/902, 359/903, 359/904, 359/905, 359/906, 359/907, 359/908, 359/909, 359/910, 359/911, 359/912, 359/913, 359/914, 359/915, 359/916, 359/917, 359/918, 359/919, 359/920, 359/921, 359/922, 359/923, 359/924, 359/925, 359/926, 359/927, 359/928, 359/929, 359/930, 359/931, 359/932, 359/933, 359/934, 359/935, 359/936, 359/937, 359/938, 359/939, 359/940, 359/941, 359/942, 359/943, 359/944, 359/945, 359/946, 359/947, 359/948, 359/949, 359/950, 359/951, 359/952, 359/953, 359/954, 359/955, 359/956, 359/957, 359/958, 359/959, 359/960, 359/961, 359/962, 359/963, 359/964, 359/965, 359/966, 359/967, 359/968, 359/969, 359/970, 359/971, 359/972, 359/973, 359/974, 359/975, 359/976, 359/977, 359/978, 359/979, 359/980, 359/981, 359/982, 359/983, 359/984, 359/985, 359/986, 359/987, 359/988, 359/989, 359/990, 359/991, 359/992, 359/993, 359/994, 359/995, 359/996, 359/997, 359/998, 359/999, 359/1000, 359/1001, 359/1002, 359/1003, 359/1004, 359/1005, 359/1006, 359/1007, 359/1008, 359/1009, 359/1010, 359/1011, 359/1012, 359/1013, 359/1014, 359/1015, 359/1016, 359/1017, 359/1018, 359/1019, 359/1020, 359/1021, 359/1022, 359/1023, 359/1024, 359/1025, 359/1026, 359/1027, 359/1028, 359/1029, 359/1030, 359/1031, 359/1032, 359/1033, 359/1034, 359/1035, 359/1036, 359/1037, 359/1038, 359/1039, 359/1040, 359/1041, 359/1042, 359/1043, 359/1044, 359/1045, 359/1046, 359/1047, 359/1048, 359/1049, 359/1050, 359/1051, 359/1052, 359/1053, 359/1054, 359/1055, 359/1056, 359/1057, 359/1058, 359/1059, 359/1060, 359/1061, 359/1062, 359/1063, 359/1064, 359/1065, 359/1066, 359/1067, 359/1068, 359/1069, 359/1070, 359/1071, 359/1072, 359/1073, 359/1074, 359/1075, 359/1076, 359/1077, 359/1078, 359/1079, 359/1080, 359/1081, 359/1082, 359/1083, 359/1084, 359/1085, 359/1086, 359/1087, 359/1088, 359/1089, 359/1090, 359/1091, 359/1092, 359/1093, 359/1094, 359/1095, 359/1096, 359/1097, 359/1098, 359/1099, 359/1100, 359/1101, 359/1102, 359/1103, 359/1104, 359/1105, 359/1106, 359/1107, 359/1108, 359/1109, 359/1110, 359/1111, 359/1112, 359/1113, 359/1114, 359/1115, 359/1116, 359/1117, 359/1118, 359/1119, 359/1120, 359/1121, 359/1122, 359/1123, 359/1124, 359/1125, 359/1126, 359/1127, 359/1128, 359/1129, 359/1130, 359/1131, 359/1132, 359/1133, 359/1134, 359/1135, 359/1136, 359/1137, 359/1138, 359/1139, 359/1140, 359/1141, 359/1142, 359/1143, 359/1144, 359/1145, 359/1146, 359/1147, 359/1148, 359/1149, 359/1150, 359/1151, 359/1152, 359/1153, 359/1154, 359/1155, 359/1156, 359/1157, 359/1158, 359/1159, 359/1160, 359/1161, 359/1162, 359/1163, 359/1164, 359/1165, 359/1166, 359/1167, 359/1168, 359/1169, 359/1170, 359/1171, 359/1172, 359/1173, 359/1174, 359/1175, 359/1176, 359/1177, 359/1178, 359/1179, 359/1180, 359/1181, 359/1182, 359/1183, 359/1184, 359/1185, 359/1186, 359/1187, 359/1188, 359/1189, 359/1190, 359/1191, 359/1192, 359/1193, 359/1194, 359/1195, 359/1196, 359/1197, 359/1198, 359/1199, 359/1200, 359/1201, 359/1202, 359/1203, 359/1204, 359/1205, 359/1206, 359/1207, 359/1208, 359/1209, 359/1210, 359/1211, 359/1212, 359/1213, 359/1214, 359/1215, 359/1216, 359/1217, 359/1218, 359/1219, 359/1220, 359/1221, 359/1222, 359/1223, 359/1224, 359/1225, 359/1226, 359/1227, 359/1228, 359/1229, 359/1230, 359/1231, 359/1232, 359/1233, 359/1234, 359/1235, 359/1236, 359/1237, 359/1238, 359/1239, 359/1240, 359/1241, 359/1242, 359/1243, 359/1244, 359/1245, 359/1246, 359/1247, 359/1248, 359/1249, 359/1250, 359/1251, 359/1252, 359/1253, 359/1254, 359/1255, 359/1256, 359/1257, 359/1258, 359/1259, 359/1260, 359/1261, 359/1262, 359/1263, 359/1264, 359/1265, 359/1266, 359/1267, 359/1268, 359/1269, 359/1270, 359/1271, 359/1272, 359/1273, 359/1274, 359/1275, 359/1276, 359/1277, 359/1278, 359/1279, 359/1280, 359/1281, 359/1282, 359/1283, 359/1284, 359/1285, 359/1286, 359/1287, 359/1288, 359/1289, 359/1290, 359/1291, 359/1292, 359/1293, 359/1294, 359/1295, 359/1296, 359/1297, 359/1298, 359/1299, 359/1300, 359/1301, 359/1302, 359/1303, 359/1304, 359/1305, 359/1306, 359/1307, 359/1308, 359/1309, 359/1310, 359/1311, 359/1312, 359/1313, 359/1314, 359/1315, 359/1316, 359/1317, 359/1318, 359/1319, 359/1320, 359/1321, 359/1322, 359/1323, 359/1324, 359/1325, 359/1326, 359/1327, 359/1328, 359/1329, 359/1330, 359/1331, 359/1332, 359/1333, 359/1334, 359/1335, 359/1336, 359/1337, 359/1338, 359/1339, 359/1340, 359/1341, 359/1342, 359/1343, 359/1344, 359/1345, 359/1346, 359/1347, 359/1348, 359/1349, 359/1350, 359/1351, 359/1352, 359/1353, 359/1354, 359/1355, 359/1356, 359/1357, 359/1358, 359/1359, 359/1360, 359/1361, 359/1362, 359/1363, 359/1364, 359/1365, 359/1366, 359/1367, 359/1368, 359/1369, 359/1370, 359/1371, 359/1372, 359/1373, 359/1374, 359/1375, 359/1376, 359/1377, 359/1378, 359/1379, 359/1380, 359/1381, 359/1382, 359/1383, 359/1384, 359/1385, 359/1386, 359/1387, 359/1388, 359/1389, 359/1390, 359/1391, 359/1392, 359/1393, 359/1394, 359/1395, 359/1396, 359/1397, 359/1398, 359/1399, 359/1400, 359/1401, 359/1402, 359/1403, 359/1404, 359/1405, 359/1406, 359/1407, 359/1408, 359/1409, 359/1410, 359/1411, 359/1412, 359/1413, 359/1414, 359/1415, 359/1416, 359/1417, 359/1418, 359/1419, 359/1420, 359/1421, 359/1422, 359/1423, 359/1424, 359/1425, 359/1426, 359/1427, 359/1428, 359/1429, 359/1430, 359/1431, 359/1432, 359/1433, 359/1434, 359/1435, 359/1436, 359/1437, 359/1438, 359/1439, 359/1440, 359/1441, 359/1442, 359/1443, 359/1444, 359/1445, 359/1446, 359/1447, 359/1448, 359/1449, 359/1450, 359/1451, 359/1452, 359/1453, 359/1454, 359/1455, 359/1456, 359/1457, 359/1458, 359/1459, 359/1460, 359/1461, 359/1462, 359/1463, 359/1464, 359/1465, 359/1466, 359/1467, 359/1468, 359/1469, 359/1470, 359/1471, 359/1472, 359/1473, 359/1474, 359/1475, 359/1476, 359/1477, 359/1478, 359/1479, 359/1480, 359/1481, 359/1482, 359/1483, 359/1484, 359/1485, 359/1486, 359/1487, 359/1488, 359/1489, 359/1490, 359/1491, 359/1492, 359/1493, 359/1494, 359/1495, 359/1496, 359/1497, 359/1498, 359/1499, 359/1500, 359/1501, 359/1502, 359/1503, 359/1504, 359/1505, 359/1506, 359/1507, 359/1508, 359/1509, 359/1510, 359/1511, 359/1512, 359/1513, 359/1514, 359/1515, 359/1516, 359/1517, 359/1518, 359/1519, 359/1520, 359/1521, 359/1522, 359/1523, 359/1524, 359/1525, 359/1526, 359/1527, 359/1528, 359/1529, 359/1530, 359/1531, 359/1532, 359/1533, 359/1534, 359/1535, 359/1536, 359/1537, 359/1538, 359/1539, 359/1540, 359/1541, 359/1542, 359/1543, 359/1544, 359/1545, 359/1546, 359/1547, 359/1548, 359/1549, 359/1550, 359/1551, 359/1552, 359/1553, 359/1554, 359/1555, 359/1556, 359/1557, 359/1558, 359/1559, 359/1560, 359/1561, 359/1562, 359/1563, 359/1564, 359/1565, 359/1566, 359/1567, 359/1568, 359/1569, 359/1570, 359/1571, 359/1572, 359/1573, 359/1574, 359/1575, 359/1576, 359/1577, 359/1578, 359/1579, 359/1580, 359/1581, 359/1582, 359/1583, 359/1584, 359/1585, 359/1586, 359/1587, 359/1588, 359/1589, 359/1590, 359/1591, 359/1592, 359/1593, 359/1594, 359/1595, 359/1596, 359/1597, 359/1598, 359/1599, 359/1600, 359/1601, 359/1602, 359/1603, 359/1604, 359/1605, 359/1606, 359/1607, 359/1608, 359/1609, 359/1610, 359/1611, 359/1612, 359/1613, 359/1614, 359/1615, 359/1616, 359/1617, 359/1618, 359/1619, 359/1620, 359/1621, 359/1622, 359/1623, 359/1624, 359/1625, 359/1626, 359/1627, 359/1628, 359/1629, 359/1630, 359/1631, 359/1632, 359/1633, 359/1634, 359/1635, 359/1636, 359/1637, 359/1638, 359/1639, 359/1640, 359/1641, 359/1642, 359/1643, 359/1644, 359/1645, 359/1646, 359/1647, 359/1648, 359/1649, 359/1650, 359/1651, 359/1652, 359/1653, 359/1654, 359/1655, 359/1656, 359/1657, 359/1658, 359/1659, 359/1660, 359/1661, 359/1662, 359/1663, 359/1664

BIM Process

Continued from page 64



A mechanical HVAC model of the VA Medical Center Las Vegas.

implementation includes all parties involved in the project. At the most fundamental level we can implement collision-detection, which allows the team to solve spatial relations issues. But space allocation and figuring out how everything fits together doesn't adequately describe the BIM process.

The current trend in BIM implementation is with 4D, 5D and XD technologies. Recent developments in software enable you to not only identify how things fit together but when they fit together. This element of time is the fourth dimension of BIM and resolves conflicts that would arise during trade sequencing, or "time-clashes." We can now simulate the entire construction process to maximize field productivity and significantly reduce or eliminate scheduling conflicts.

Also, the ability to extract quantities directly from the model and assign costs to those quantities is now possible. The cost information embedded within the object(s) is the fifth dimension of BIM. This is especially useful on Design-Assist and Design-Build projects where decisions can be made to maintain budgets and keep the project on target. Quantity take-off (QTO) is now an automated process which facilitates the capability to produce a model-based estimate (MBE).

Discussions on the benefits of BIM are usually centered on project delivery. But other examples of clever BIM innovations are the ability to perform code compliance checking, thermal analysis, energy consumption and optimization, facilities management, asset management, and beyond. These examples are commonly referred to as XD or the X dimensions of BIM. New ideas are continually being introduced to improve the entire building lifecycle.

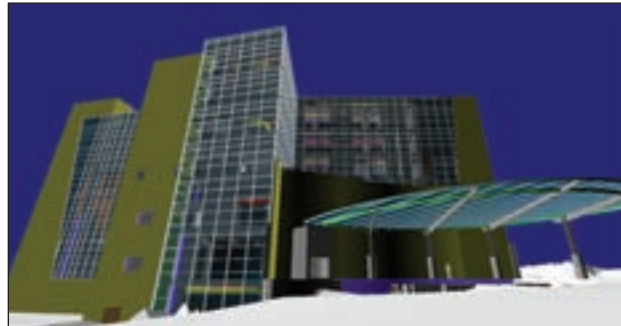
The sales pitch for BIM is typically all about reducing risk. Not just for the trade contractors but for the owner, the architect, engineer and others. But the benefit of improved visualization is much more powerful than that. By leveraging the available technology and utilizing the model as our vehicle to communicate, we can now efficiently solve problems that have plagued the building industry since antiquity. By harnessing these improvements we, in turn, improve the standard of care for our

customers, which inevitably translates to value for the entire team. And all of this takes place in a virtual environment long before the building actually exists and much sooner than conventionally possible.

BIM has and will open many doors to improve the delivery of projects but there are definitely obstacles that have to be dealt with. Addressing the realities of BIM and what is achievable is a key to success.

The traditional plan/spec contract structure normally assigns roles and responsibilities; this is also being challenged. New contractual language is being introduced that is designed to facilitate an effective BIM execution plan but many of these arrangements are either in progress or have yet to be tested. Unfortunately no one really has all of the answers and it will, to some degree, require a leap of faith.

Without a doubt, a successful BIM implementation requires a commitment from the entire team. This level of commitment is required to work through various challenges that present themselves. Challenges such as software interoperability, limitations on digital data transfer and storage, training, implementation, integration, liability, etc., all will have to be addressed. And as with anything in life, there are risks. Luckily there are scores of BIM enthusiasts dedicated to making this a successful



A BIM rendering of the Sutter Medical Center in Castro Valley, Calif.

endeavor. This includes a number of examples of the technology being used overseas. As more BIM-enabled projects are completed, the more lessons learned, the more we can refine the process.

Despite the challenges with BIM, it's intuitive to proceed further down this path. The future of BIM is promising as the technology continues to evolve. Advances in software and computing power will allow more data to be included in the model, allow it to be shared more readily and put it within reach of more people. Advances in delivery methods will allow teams to work more efficiently with greater accuracy. All of which improves our ability to produce better buildings. ■

Eric Winslow has been in the construction industry for 17 years as a manager, designer, fabricator and installer. He currently leads the Engineering & BIM department at Superior Air Handling in Clearfield, Utah, where he continues to be directly involved in operational deployment of technology and BIM implementation. He can be reached at eric.winslow@sahco.com.