

Report No. UT-11.09

EVALUATION OF AN INDEPENDENT CADD PLATFORM FOR UDOT

Prepared For:

Utah Department of Transportation
Research Division

Submitted by:

Utah State University - Department of
Civil & Environmental Engineering

Authored by:

Kevin Heaslip, Ph.D., PE
Wesley Boggs
Travis Evans
Michael Langford

May 2011

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Inside of Cover

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16. Abstract The following report presents a research study conducted on data sharing between MicroStation and AutoCAD. In 2009, MicroStation and Autodesk developed a file sharing platform that made the conversion process more seamless by sharing their data libraries for their respective CAD platforms. From reviewing the problems from the conversion, it was found that selecting the right seed file can make the conversion process more seamless, however, there are still challenges in the interoperability of the two systems. In order to determine problems with the conversion process, online forums that included CADD professionals were reviewed and a small drawing was converted from AutoCAD to MicroStation taking note of any problems. Contact was also made with DOTs that have had experience in receiving files in both the *.dgn and *.dwg formats. To better understand the needs of stakeholders, consultants, contractors, cities, and utility companies were surveyed to determine problems they have experienced and their needs. This report presents the findings and recommendations from the study.					
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I. EXECUTIVE SUMMARY

The following report presents a research study conducted on file sharing between MicroStation and AutoCAD design packages. In the past, MicroStation has been a more appropriate choice for civil engineering tasks. It is also able to generate the large plans used predominantly by USDOT's. In the last 15 years, Autodesk (the makers of AutoCAD) has taken steps towards enabling the sharing of features between MicroStation and AutoCAD.

MicroStation users benefit from the wide use of the software by the many federally funded DOT's that use the *.dgn format as their primary means of submitting drawing plans. Due to its cost, MicroStation has not been embraced by the private sector, which instead opts for AutoCAD due to its minimal starting and operating cost.

Autodesk moved to capture the civil engineering market in its 2004 version of AutoCAD by including an export/import feature for conversion from *.dgn to *.dwg. This attempt included added features at a much lower cost than MicroStation. While including most of the same functions as MicroStation, some of the drawings' lines and text formats did not transfer properly which forced redrawing of the plans.

In 2009, MicroStation and Autodesk developed a file-sharing platform that made the conversion process more seamless by sharing their data libraries for their respective CAD platforms. From reviewing the problems from the conversion, it was found that selecting the right seed file could eliminate most of the conversion problems.

In order to determine problems with the conversion process, online forums that included CADD professionals were reviewed and a small drawing was converted from AutoCAD to MicroStation taking note of any problems. Contact was also made with DOTs that have had experience in receiving files in both the *.dgn and *.dwg formats. To better understand the needs of stakeholders, consultants, contractors, cities, and utility companies were surveyed to determine problems they have experienced and their needs. This report finds that acceptance of .dwg files by UDOT is not possible given the current constraints in the software and institutional considerations within the department.

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1.0 Introduction

In the 1980s, the majority of State Departments of Transportation (DOTs) began using Bentley's MicroStation system exclusively because MicroStation was able to handle large and complex projects more efficiently than AutoCAD. However, AutoCAD remained the choice of many private sector firms who worked with DOTs on various projects. This presented a problem because MicroStation required all project design drawings to be submitted in the *.dgn format instead of the *.dwg format used by AutoCAD which made collaboration difficult.

In 2000, Autodesk developed AutoCAD Civil 3D that was comparable to Bentley's InRoads and Geopak add on roadway design packages. This provided competing software for roadway design that was offered at a much cheaper price. In turn, many of local governments and small engineering firms gravitated to Autodesk. For consulting firms that worked with DOT and local agencies in design, this necessitated companies to purchase both programs. Firms that opted to continue working on DOT projects are required to maintain Microstation licenses or convert the files to .dgn themselves or through a third party.

UDOT currently requires all CADD digital file deliverables to be in native *.dgn (MicroStation) file format. Currently the department has significant staff time increases when project deliverables are submitted in *.dwg, *.dxf, or *.pdf files. When files other than .dgn are received, UDOT staff has to convert or redraw the digital drawings to UDOT standards which causes unnecessary rework and unsuspected workloads.

Additionally, UDOT's use of native *.dgn format provides challenges to exchange CADD digital design data formats between UDOT and local governments, agencies, utility companies, and numerous engineering companies within the state of Utah. While Autodesk and Bentley have announced a concerted effort to streamline the conversion process, it is necessary to review this procedure and the impacts that allowing CADD files to be submitted in multiple formats will have on UDOT.

A review of the interoperability of .dgn and .dwg file formats was necessitated by a 2008 cooperative agreement between Bentley and Autodesk which aimed at bridging the gap between the *.dgn and *.dwg formats. This agreement allowed Bentley to include Autodesk's RealDWG

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libraries in Bentley products and allowed Autodesk to do the same with Bentley's DGN libraries. This was a major step towards a more seamless conversion between the two formats, making collaboration between various stakeholders using different platforms easier.

In order to determine if UDOT should accept and use multiple CADD formats in addition to the current *.dng file format the following tasks were completed:

1. Conduct a review of technical issues in the sharing of *.dgn, *.dwg, and *.dxf in one environment
2. Conduct a review of current file conversion techniques and commercial packages for CADD files
3. Contact and Survey other DOTs with experience in receiving CADD files in multiple formats
4. Conduct a focus group with UDOT staff and other stakeholders
5. Survey consultants and construction companies to identify problems with using various CADD platforms

These tasks allowed the researchers to evaluate the potential impacts resulting from UDOT allowing the submittal of multiple CADD file formats. Additionally, the results of the study provide insight to the need present for allowing such submittals. The contents of this report detail the tasks conducted and the results of the research.

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2.0 Review of CADD Software Available for DOT Projects

To further understand dynamics within the CADD community, research was conducted on licensing and training costs and the market share of each individual CADD software package.

2.1 CADD Licensing and Training Cost

Research was conducted to compare the costs of operating AutoCAD and Microstation. Many consultants and localities have cited the increased cost of Microstation as the biggest contributing factor of their preference for AutoCAD. When the costs were compared MicroStation is nearly twice as expensive as AutoCAD Civil 3D as shown in Table 1. The difference in price comes from the need to buy the InRoads Civil Suite add-on and pay the yearly subscriptions for both the program and the add-on. Although it is a widely held opinion that InRoads has features that are more tailored towards roadway design because of its ability to handle large and complex projects. Civil 3D is gaining popularity, especially in the private sector, because it is significantly cheaper.

Table 1: Cost for MicroStation and AutoCAD

The Cost For Opening A Civil Engineering Firm - Just Software			
MicroStation	\$ 4,795.00	AutoCAD Civil 3D	\$ 7,995.00
Subscription	\$ 725.00	Subscription	\$ 995.00
InRoads Civil Suite	\$ 9,000.00		
Subscription	\$ 1,800.00		
Final Price	\$ 16,320.00		\$ 8,990.00

When training was considered it was shown that both companies offer training at similar prices, which have been shown to be competitive in the market. However, Autodesk has made its products widely available to high schools and universities to incorporate into their training curriculums. Bentley has chosen not to make their products available to high schools and universities, causing that firms using MicroStation have to spend additional time and money training new engineers on Microstation because they may not have been exposed to it in their education. Training costs found for both systems are presented in Table 2.

Table 2: CADD Program Training Costs

Education - Training			
Company	Software	Cost	Type
CADD Train	AutoCAD	\$ 1,569.00	Online
Cad Institute	AutoCAD	\$ 351.00	Online
Cad Institute	AutoCAD	\$ 373.00	Online
Bentley	MicroStation	\$ 1,400.00	Classroom

2.2 AutoCAD and Microstation Market Share

As of 2009, it is estimated that AutoCAD has 7.5 million installed seats, which is a 55% share of the total CADD market (Foster, 2009). It is estimated that the MicroStation share of the market is 11% (1.5 million licenses). These figures are for the entire CADD market, which includes CADD applications for outside of transportation and civil engineering. Values that are representative of the Transportation section of this market are presented in the consultant survey section of this report. Figure 1 presents the percentage of the total CADD market held by each software platform.

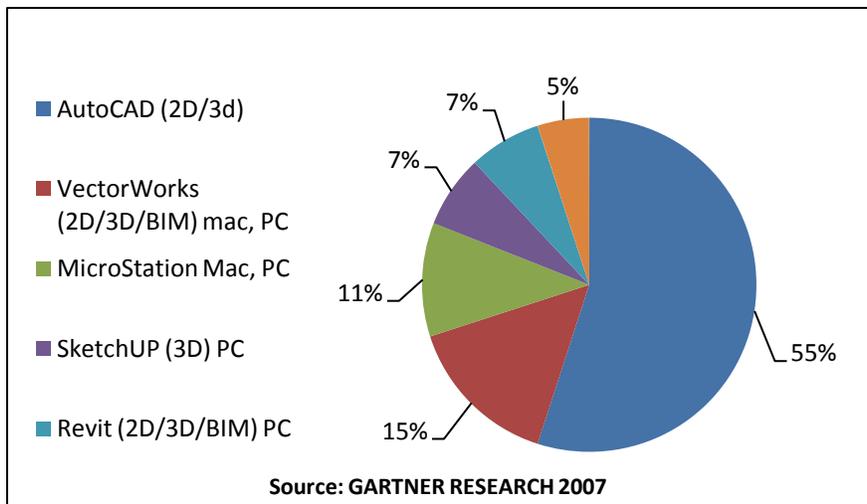


Figure 1: Market Share of CADD Market (Foster, 2009)

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3.0 Analysis of the Interoperability of AutoCAD and Microstation

This section summarizes the process of converting an AutoCAD drawing (*.dwg) to MicroStation (*.dgn) format. It contains a conversion table, detailed conversion process, common conversion issues, CADD forum discussions on conversion techniques, and a conclusion on the current conversion process.

3.1 Conversion Tables

The conversion tables shown in Tables 3 and 4 were provided by Bentley to assist their users with conversions to .dwg. The tables show the correlation between the two formats in many different attributes. For example, “Layers” in AutoCAD are “Levels” in MicroStation. These tables can help understand how to create seed files and ensure they are converting in the most efficient way possible.

3.2 Converting *.dwg to *.dgn in AutoCAD

To improve the file sharing and conversion needs of the user, AutoCAD has settings in place to convert from the *.dwg format to the *.dgn format. The following steps are based on AutoCAD versions 2008 and later exporting to MicroStation V7: On the “Menu” tool bar, highlight the “File” tab and click on the “Export” tab in the Export dialog box then, select “Export to Other Formats” and the subdirectory shown in **Error! Reference source not found.** will appear.

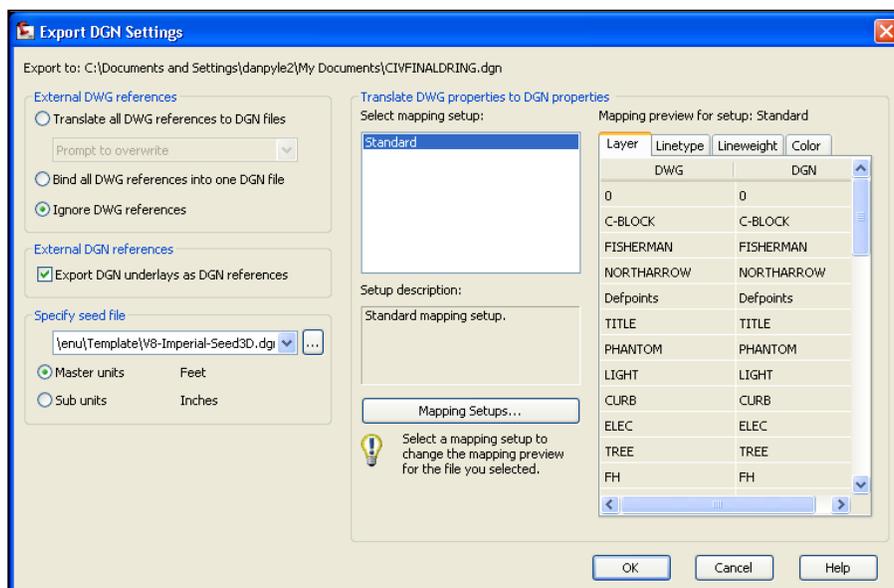


Figure 2: Export *.DWG to *.DGN.

Table 3: .DGN EXPORT Conversion Table part 1. (Autodesk, 2008)

DGNEXPORT Conversion Table

The following table lists the DGN objects and features that are supported for export, and notes on the scope of the translation.

DWG to DGN Conversion Table		
AutoCAD	MicroStation	Notes
Geometric Objects	Geometric Elements	The following DWG objects are translated into DGN elements: line, xline, ray, polyline, arc, circle, spline (NURBS), ellipse, elliptical arc, point, donut, mline, hatch (including gradient fills), and wipeout. Variable width polylines maintain only their starting width when translated into SmartLines.
Layers	Levels	Invalid DWG characters in layer names are converted to spaces.
Colors	Colors	Colors are matched as closely as possible. Colors set with the ACI (AutoCAD Color Index) are translated directly to the DGN color index. If TrueColor is used and a direct match of RGB values is available in the DGN color index, the colors are also mapped directly. If a TrueColor match is not available, an RGB value is added to the DGN color index.
Linetypes	Line Styles	Custom linetypes are unsupported and could produce unexpected results.
Blocks	Cells	Blocks are exported as shared cells. Dynamic blocks are also exported as cells and lose their dynamic behavior. Invisible, Constant, Verify, and Preset attributes are all converted into tags.
Single-line Text Objects, Multiline Text Objects, Text Styles	Text, Text Nodes, Text Styles	The visual integrity of multiline text is maintained. However, if exported multiline text objects are edited in MicroStation, the formatting is lost. TrueType and SHX fonts in AutoCAD are exported to MicroStation V7 as Engineering. This can result in many visual differences.
Tables	Tables	Table objects are exported as cell elements composed of lines and text.

Table 4 - *.DGNEXPORT Conversion Table part 2. (Autodesk, 2008)

Fields	Fields	<p>In general, fields are translated as static text. The exceptions are fields that behave identically in both products. This includes the Date fields <i>CreateDate</i>, <i>SaveDate</i>, and <i>PlotDate</i>, and the Document property fields <i>Author</i>, <i>Filename</i>, and <i>Filesize</i>.</p> <p>Note Use the MicroStation Key-in utility to update text containing fields (field update all).</p>
Dimensions, Dimension Styles	Dimensions, Dimension Styles	<p>The size, spacing, style, and shape of dimensions may vary slightly. Dimension associativity is maintained whenever possible, and the correct dimension values are always maintained.</p>
Raster Images	Raster Images	<p>These image file types are supported: <i>.bmp</i>, <i>.cal</i>, <i>.tif</i>, <i>.png</i>, <i>.tga</i>, <i>.jpg</i>, <i>.gif</i>, <i>.rlc</i>, <i>.bil</i>, and <i>.pcx</i>. All other image file types are discarded.</p>
DWG References	DGN References	<p>Depending on the export option specified, all referenced DWG files, including nested DWG references, are either converted into DGN files, combined into a single DGN file as cells, or discarded.</p> <p>Note MicroStation V7 does not support nested references to references that are merged into the host file.</p>
DWG Model	DGN Design Model	<p>The model in a DWG file is converted into a DGN file.</p>
DWG Layout	DGN Sheet Model	<p>When exporting to V8, any initialized layouts are converted into sheet models in the DGN file.</p> <p>V7 only supports one model. For V7, several DGN files can be exported: one for the model and the other DGN files for any initialized layouts in the DWG file. The layout names get appended to the exported DGN file <filename> - Layout1.dgn.</p>
AEC Objects		<p>AEC objects are not supported. Use the EXPORTTOAUTOCAD command to convert AEC objects to base ACAD objects before exporting to DGN.</p>

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At this stage of the conversion process, comments from users in online forums suggest that it is important to note that a shift occurs in the placement of the drawings and some drawings will not translate when doing a direct import/export of files in *.dwg→*.dgn. To avoid this, the original author must send their project seed file along with the design file. Then the seed file must be saved on the receiving system, once in the *.dgn Export window, the seed file must be selected as the one needed for conversion. The file then can be saved as either V8 *.dgn or V7 *.dgn.

MicroStation also has settings in place to facilitate the conversion of drawings in the (*.dgn) format to the AutoCAD (*.dwg) format. To export files from MicroStation to AutoCAD, the following process is followed: On the “Menu” tool bar, click on the “File” option and scroll down to the “Export” option. Then, select either *.dwg or *.dxf formats as the conversion formats. After selecting the format, the Export window appears. Since it is a *.dwg conversion, the format to save it is AutoCAD drawing files (*.dwg).

MicroStation and AutoCAD have also incorporated settings to facilitate the importation of drawings. To import files from the MicroStation (*.dgn) format to the AutoCAD (*.dwg) the following process is followed: On the “Menu” tool bar, click on the “File” tab and select the “Import” option. Then, select *.dgn format as the conversion format. An import file window opens where you will be prompted to choose the file to be used for import (NB: use the Seed files). The next window that appears is the “Import DGN Settings” window shown in Figure 3.

In this window, the user has to select a model from the *.dgn File. Under the External *.dwg references, select the “Translate All *.dwg references to *.dgn files”. You will be prompted to overwrite the file and bind all reference or to ignore all references. You will also specify your conversion units under “Specify *.dgn Units to Convert to *.dgn”. To avoid multiple overlaying of lines and drawings, you must select “Explode Text Nodes to Text Elements”. Once these options have been selected, they will be saved making the conversion process simpler.

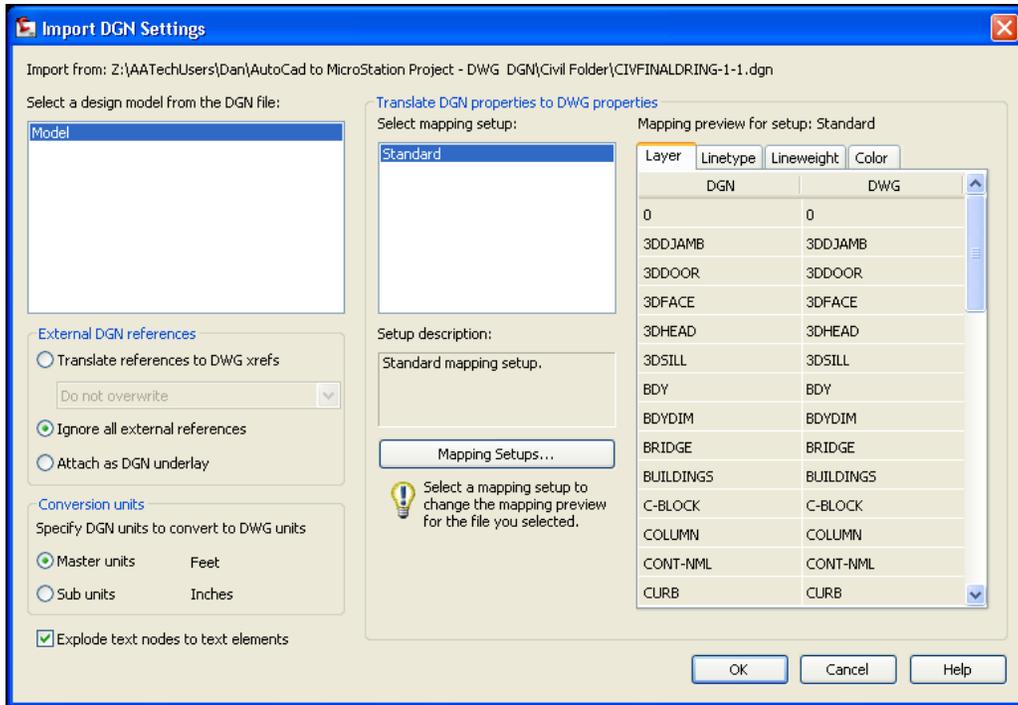


Figure 3: Import screen from *.dwg to *.dgn.

3.3 Conversion Issues

To evaluate the conversion process between AutoCAD and MicroStation, a drawing was converted using the process described in the previous section. The only issue was the text alignment of the drawing was skewed when opened in MicroStation. The original drawing in AutoCAD is shown in Figure 4 and the converted drawing in MicroStation is shown in Figure 5.

POINT	TRANSIT			TOTAL STATION				
	ANGLE	ELEVATION	DISTANCE	HD	VA	VD	SD	MAG
X ON PAD	557.949°E	3226'	31'	75.956'	88.35.08"	1.876'	1.876'	S12.55.59°E
A	3.82.9"	3246.03'	58'	79.766'	88.58.08"	1.451'	79.78'	1'26.27.29"
B	297.00.00"	3243.74'	124'	204.442'	90.6.16"	-.374'	204.463'	50.12.11"
C	342.5.00"	3252.9'	305'	299.852'	90.12.33"	-.919'	299.883'	68.00.9"
D	72.30.10"	3230.64'	36.6'	296.120'	90.7.36"	-.225'	296.120'	96.13.26"
E	106.50.00"	3224.37'	190'	132.699'	89.51.54"	-.326'	132.700'	146.32.30"
F MANHOLE	88.3.8"	3233.69'	241'	190.733'	90.1.48"	-.101'	190.733'	124.50.14"
G MANHOLE	88.3.8"	3233.69'	241'	203.262'	90.15.4"	-.889'	203.264'	83.55.35"
H POWER POLE	88.3.8"	3233.69'	241'	230.377'	90.11.17"	-.754'	203.376'	48.27.43"
I FIRE HYDRENT	35.3.8"	3254.33'	108'	36.950'	90.00.28"	-.019'	136.950'	27.7.32"
J MANHOLE	35.3.8"	3254.33'	108'	57.915'	90.1.35"	-.027'	57.912'	21.16.00"

Figure 4: Original Text in AutoCAD

TRANSIT			
POINT	ANGLE	ELEVATION	DISTANCE
X ON PAD	557°49'E	3296'	31'
A	33°2'9"	3296.03'	59'
B	49°00'00"	3293.74'	194'
C	141°25'00"	3292.9'	305'
D	79°30'10"	3290.64'	326'
E	105°20'00"	3294.57'	301'
F MANHOLE	88°3'6"	3293.69'	241'
G FIRE HYDRENT	35°3'6"	3294.33'	108'

TOTAL STATION					
POINT	HD	VA	VD	SD	
1 X ON PAD	75.986'	88°35'08"	1.876'	1.878'	S32°55'59"E
A	79.766'	88°58'08"	1.551'	79.78'	126°27'29"
B	204.452'	90°6'16"	-.374'	204.463'	50°12'1"
C	299.882'	90°15'33"	-.919'	299.883'	65°00'9"
D	298.129'	90°2'36"	-.225'	298.129'	96°13'26"
E	152.699'	89°51'34"	-.326'	152.700'	146°57'30"
F MANHOLE	190.733'	90°1'48"	-.101'	190.733'	124°50'14"
G MANHOLE	203.262'	90°15'4"	-.889'	203.264'	83°55'38"
H POWER POLE	230.377'	90°11'17"	-.754'	230.376'	48°27'43"
I FIRE HYDRENT	136.950'	90°00'28"	-.019'	136.950'	27°7'32"
J MANHOLE	57.915'	90°1'35"	-.027'	57.912'	21°18'00"

Figure 5: Drawing opened in MicroStation.

3.4 CADD User Forums Survey

Because the conversion process between MicroStation and AutoCAD is relatively new, there is not much reference material available. To better understand the issues related to the conversion process, a review was made of seven CAD forums frequented by professionals who work with both CADD programs. Below is a list of comments from the forums providing insight from practitioners into the conversion process.

AutoCAD 2010

- Use MicroStation to import *.dwg to *.dgn instead of exporting from AutoCAD (AutoCAD 2010, 2007).
- If the *.dwg is exported from AutoCAD save it down to the 2007 version first. (AutoCAD 2010, 2007).
- Explode all Civil 3D objects before the conversion is made. (AutoCAD 2010, 2007).
 - The problem with exploding is that the notation no longer scales or orientates itself to the viewport, or to the scale of the drawing. The rescaling of the text or exploding objects at multiple scales can be very time consuming, and this is a very large job. (AutoCAD 2010, 2007).

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- The Map 3D Export to MicroStation requires all the Civil 3D objects to be converted into vanilla AutoCAD objects the same as exporting to ESRI shape format. As for the layers, blocks and etc use what is called a **seed file** that will convert the layers to the MicroStation levels and blocks to their cells when using the map export. The **seed file should be provided by the DOTs**, In Tennessee they provide all the info needed to convert to their standards. (AutoCAD 2010, 2007).

CADTutor – AutoCAD/MicroStation Issues

- When converting from *.dgn to *.dwg back to *.dgn the translation comes in a few feet off (CADTutor, 2008).
- As for units, MicroStation V8 introduced the concept of a *.dgn file being unit aware, but the people writing the code were not civil or survey savvy so it only understood International Feet and Metric units. It was necessary to adjust certain files to **add US Survey Feet** to the mix. When working with *.dwg files, it is also necessary therefore to specify US Survey Feet, not simply feet (CADTutor, 2008).

AutoCAD Civil 3D Discussion Group

- To get a better conversion, save the *.dwg to an r2000 format (MicroStation v7 doesn't seem to handle any later formats than that) then open or import that r2000 file into MicroStation. From there attach the proper color table (for some reason when a *.dwg files is brought in it overrides the color table that is already attached so reattach the color table) and then select the text entities and change the font (AutoCAD Civil 3D, 2007).
- MicroStation does not have the object enablers used by Civil 3D so you will have to first **export to AutoCAD** (That sounds funny-"export Civil 3D to AutoCAD") (AutoCAD Civil 3D, 2007).
- All seems to convert OK except the Civil 3D labels that have **annotative scaling** attached to them (grades, contour labels) (AutoCAD Civil 3D, 2007).

CADform

- When importing a *.dgn file, specify the conversion units (master units or sub-units) based on the *.dwg file's drawing units. For example, if a *.dgn file is received with

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master units set to meters, and sub-units set to millimeters, and the drawing units need the *.dwg file to be in meters, then select master units in the Import *.dgn Settings dialog box. This matches the meters in the *.dgn file to the meters in the *.dwg file (CADform, 2007).

BE Communities

- The key things to watch out for are: line types / line styles, text styles (fonts), and a matched set of ctb/tbl files. Use *.DWG files for standard borders (including MicroStation projects), and also *.DWG block files (instead of cell libraries) so that common data won't replicate. **Package the standards as AutoCAD templates (MicroStation seed) files**, so that all of the Layers (levels), line types (line styles), text/dimension styles, blocks (shared cells), etc. are part of the **template/seed file**. Then have an AutoCAD color table (CTB file) that is an identical match to the MicroStation Pen table (TBL file), thus ensuring that plot output is identical (BE Communities, 2009).

Draftsperson

- The issues with MicroStation have occurred when trying to read a MicroStation drawing into AutoCAD via DXF. This might be because of the way that MicroStation creates the DXF file, but there is a considerable loss in precision. My understanding this has to do with the type of data storage that MicroStation uses. I have read in countless DXF files produced by other applications without any precision issues, except DXF files produced by MicroStation (Draftsperson, 2009).

CADTutor – Converting from MicroStation to AutoCAD

- The *.dgn import and export capabilities are designed to provide a fundamental exchange of information between MicroStation V7/V8 *.dgn files and AutoCAD *.DWG files. However, translating data from one format to a completely different format inevitably require compromises and substitutions (CADTutor, 2007).
 - Simple geometric objects such as lines, arcs, and circles, and properties such as layer assignments correlate directly between the *.dwg and *.dgn data formats.
 - Data with built-in features or variations are visually approximated. For example, text and dimensions might have specialized formatting, and color definitions might be customized.

- Some data cannot be translated completely. For example, product-specific features such as data fields or dynamic blocks can be represented visually but not behaviorally.

3.5 Conversion Process Summary

The processes for converting a drawing created in Autodesk to MicroStation are fairly detailed. To make the conversion, one needs to have Autodesk Xref files contain the same set values and conversion parameters as the format it is moving to (if measurement in CAD is ft., measure in MicroStation should also be in ft). The use of external references creates large problems because of the need to overlay information and the coordination with the master seed files. The use of external references causes many problems in the conversion process that are difficult to overcome.

One of the main problems reported in the forums was the use of MicroStation seed files. Using the right seed files eliminates most of the small issues like text alignment and layers. It was also interesting to read that it works better to import *.dwg files in MicroStation rather than to export the file to *.dgn from AutoCAD.

From the information in the forums, the following points were made to optimize the data transfer from the MicroStation *.dgn file format. The creator of the MicroStation drawings should consider the following recommendations:

- Create a separate *.dgn file for each design model
- Do not reference sheet models from design models
- Minimize the use of custom objects and other data unique to MicroStation
- Use ByLevel for color, line style, and weight properties
- Use simple line styles as much as possible
- Use simple patterns and pattern styles
- Use TrueType text fonts rather than SHX text fonts
- Use defined styles for dimensions and text rather than a “none” style
- Use simple dimension styles if possible
- Use shared cells as opposed to normal (library) cells
- Work primarily in one format, *.dwg or *.dgn, rather than switching back and forth

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4.0 Other State's CADD Platforms & Experiences

In order to compare Utah's experience with the rest of the nation a survey was conducted of other states to determine which platforms were used by other DOTs and to see if other DOTs had interoperable systems. Table 5, acquired through the Tennessee DOT, shows the software used by each state DOT. Massachusetts and Alaska are the only states that use AutoCAD exclusively. Florida, New Mexico, Washington, and Wisconsin use MicroStation and AutoCAD. Tennessee provides conversion files that allow them to accept both MicroStation (*.dgn) and AutoCAD (*.dwg) files. In order to understand the current issues a DOT faces by allowing multi-platform submittals Florida (FDOT), Tennessee (TDOT), and Washington (WSDOT) were contacted and questioned typical problems they have had. The responses are outlined below.

Florida CADD Applications Support Coordinator Ray L'Amoreaux explained that top management did not want to depend on one program so they implemented both AutoCAD and MicroStation. They started a test pilot two years ago to see how using multiple would affect the internal staff at Florida DOT.

From 2000 to 2003, Tennessee DOT piloted a program allowing files to be submitted in AutoCAD and they would complete the conversion to MicroStation. CAD manager Dennis Minton said this process was "too messy" and the text alignment problem "caused a lot of headaches". He then talked about a recent project where a manager at the Tennessee DOT allowed a firm to complete a project in AutoCAD because the same project was done in *.dwg ten years ago. Now that the project is finished, Tennessee DOT wants the project to be submitted in *.dgn because they do not have AutoCAD anymore. The private firm told them that it would take one year to make all of the conversions. Mr. Minton estimated the conversion would take 20 days.

Finally, Washington CAD Managers Bill Berens and Clint Hill were contacted. They discussed how the change to allow file submissions in both file formats was made to increase the number of submissions and work output at the DOT. Bidders are asked to present their works in *.dgn format but limited conversion is offered for *.dwg files. They found the greatest issue with

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converting the files is the text overlap, line weights, style. These have been corrected in-house at WDOT. However, because MicroStation is the DOT’s main CAD format, they have encouraged most firms in the Washington State area to submit their works in *.dgn format.

Table 5: CAD Software Used by Each State.

State	Software Used	State	Software Used
Alabama	MicroStation, InRoads	Montana	MicroStation, GeoPak
Alaska	AutoCAD, Autodesk Land Desktop and AutoCAD Civil 3D	Nebraska	MicroStation, GeoPak
Arizona	MicroStation, InRoads	Nevada	MicroStation, InRoads
Arkansas	MicroStation, InRoads	New Hampshire	MicroStation, MX, LEAP, SignCAD, AutoTrack, gINT, StormCAD
California	MicroStation, CAiCE	New Jersey	MicroStation, InRoads
Colorado	MicroStation, InRoads, ProjectWise	New Mexico	Bentley, AutoDesk, Intergraph, Transoft Solutions
Connecticut	MicroStation	New York	MicroStation, ProjectWise, GuidSign, IPLOT, AutoTrack, InRoads
Delaware	MicroStation, InRoads	North Carolina	MicroStation, AutoCAD, GeoPak
Florida	MicroStation, GEOPAK, QM, Descartes, Autoturn, Guidesign, Axiom, AutoCAD Civil 3D, CAiCE, TIMS, Transport	North Dakota	MicroStation, GeoPAK, IPLOT, Axiom
Georgia	MicroStation, InRoads, CAiCE, Haestad, LEAP, Redline	Ohio	MicroStation, GeoPak, Bentley Map, IPLOT, MicroStation, InRoads, ProjectWise, QM, Storm Sanitary, CADD Storm
Hawaii	MicroStation, InRoads	Oklahoma	
Idaho	MicroStation, InRoads, PondPack, Trns.port, AutoTurn, SignCad, Culvert Master	Oregon	MicroStation, InRoads, Storm & Sanitary, Descartes, AutoTURN, GuidSIGN
Illinois	MicroStation, GeoPak	Pennsylvania	InRoads: MicroStation, Rebar, Auto Turn, IPLOT, Sign CAD
Indiana	MicroStation, MX, InRoads, ProjectWise, IPLOT, LEAP, QM, SignCAD, Descartes, Bentley Map, AutoTrack, gINT, Trns.port	Rhode Island	MicroStation, InRoads
Iowa	MicroStation	South Carolina	MicroStation, GeoPak
Kansas	MicroStation, GeoPak, Descartes, Auto Turn, Project Wise	South Dakota	MicroStation, InRoads
Kentucky	MicroStation, InRoads	Tennessee	MicroStation, GeoPak, Interplot, AutoTrack
Louisiana	MicroStation, InRoads	Texas	MicroStation, GeoPak
Maine	MicroStation, MX, InRoads, ProjectWise	Utah	MicroStation, InRoads
Maryland	MicroStation	Vermont	MicroStation, InRoads
Massachusetts	AutoCAD, Autodesk Land Desktop, Autodesk Civil 3D, Leap, Autoturn, SignCAD	Virginia	MicroStation, GeoPak
Michigan	GeoPak, AutoCAD	Washington	MicroStation, AutoCAD
Minnesota	GeoPak, MicroStation, QM, Transport, Corridor Modeler	West Virginia	MicroStation, InRoads, IPLOT, Suvey SelectCADD, RC-Pier, Guide Sign, gINT, AutoTrack, BERG, BridgeAnalysis, BridgeModeler, ComplexTruss, CONSPAN, CulvertMaster
Mississippi	MicroStation	Wisconsin	MicroStation, CAiCE, Civil 3D, Axiom, Auto Turn, Iplot
Missouri	GeoPak, MicroStation, Projectwise, Descartes, GeoPak, Culvert Master, PondPack, Trns.port, AutoTurn	Wyoming	MicroStation, GeoPak, BRASS

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In conclusion, most DOTs use MicroStation as their main design program and very few have experimented with multi-platform submittal. Out of those that have tried multi-platform submittals, none report an increase in productivity and a decrease in problems with file submittal. It is important to note that, after three years of allowing submittals in AutoCAD and MicroStation, Tennessee reverted back to allowing MicroStation (*.dgn) format only.

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5.0 Surveys of Utah CADD Stakeholders

Members of UDOT's CADD and project design staff, local governments, private engineering firms and utility companies were interviewed in an effort to uncover the challenges facing these groups by UDOT's exclusive use of MicroStation. The summary of the responses is presented below by group.

5.1 UDOT Staff Focus Group Meeting

A focus group meeting was conducted on September 2, 2010 with UDOT's CADD and project design staff to better understand challenges that are facing UDOT with the exclusive use of MicroStation. **Error! Reference source not found.** shows the professionals present and the table organization during the focus meeting.

The most important points discussed in the meeting are shown below:

- It is probably local government projects where we get most of the consultants wanting to use it (AutoCAD).
 - We still have a problem with them keeping to our standards.
 - Consultants forced to do dual submittals for advertisement purposes.
 - Some cities require the design to be done in AutoCAD and UDOT requires the design in MicroStation.
 - Is this why city bids are higher than normal?
 - We can look into letting cities do design work in AutoCAD for federally funded projects on local roads.
- Utility companies use of AutoCAD
 - We send quite a few MicroStation (*.dgn) files to them but we usually convert the files before we send them.
 - We mostly work with Utah Power and they say the conversion does not come through but when we sit down with them it works.
 - We also receive drawings of pole locations and we have them show us the locations on a map.
 - With other utility companies we have had to redraw their drawings from a *.pdf and incorporate them into are drawings.
- Why do we stay with Bentley?

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- It is a cost issue with so much training and software purchases.
- 90% of other DOTs use it.
- We are not losing any capabilities by using it.
- It is still the software of choice for Transportation Engineers.
- Autodesk and Bentley leap frog each other with the better software.
- AutoCAD is a cost savings product with the cost of the products itself and most professionals are trained with it first.
- Reason for this research project
 - All the vendors told us it was dual compatible.
 - What is it going to take to be able to have no problems with the conversion?
 - Are we going to have to set standards so we can automatically receive files?
 - Do we have resources available that could help set those up?

5.2 City Survey

Thirty Utah cities were contacted by email or phone and seven responses were received. A comprehensive, six-question questionnaire was used to collect information from the cities' officials (see Appendix A). The responses from each city are listed below.

Bountiful City - Lloyd N. Cheney, P.E. Assistant City Engineer

- City uses AutoCAD mostly because it's cheaper
- Submitted 2 projects to UDOT in 2001 and 2008
 - We provided them with *.pdf plans and they never requested *.dwg (AutoCAD) files.
 - UDOT did not seem like they had time to review the drawings so they did not seem interested in CAD design files.
- Bountiful takes pride in doing in-house designs so they do not hire consultants for projects.
- Federally funded projects have not been an issue for them but he thinks that requiring a specific program is a "heavy handed" approach.

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Herriman City - Mark Jenson, P.E. Staff Engineer 3

- UDOT recently did a road project on a state road in Herriman City where the road, sewer, and storm drain were designed in MicroStation.
 - They are now trying to locate pipes underneath the road.
 - Can only make out the centerlines and do not know where the pipes are exactly located.
 - Expects the road profile to be the hardest to convert.

Orem City - Neil R. Winterton, P.E. Design Section Manager

- City uses AutoCAD because of its versatility to handle multiple tasks.
- MicroStation is primarily transportation software and they deal with utility and water companies that use AutoCAD.
- When working with UDOT they submit drawings in a *.pdf form created from AutoCAD.
- Would not need to hire consultants if they could do their projects in AutoCAD.
- 40% of their designs they outsource to firms either to do conversions or to do the designs in MicroStation.
- This issue is a big deal and if they could do their drawings in AutoCAD they see big savings for the city.

Provo City - Dave Graves, P.E. City Engineer

- Has not seen too many problems with using AutoCAD.
- However, when doing joint projects with UDOT private firms are required to do the design in MicroStation and AutoCAD.
- This makes the project's cost more money.

Smithfield City - James P. Gass City Manager

- City uses AutoCAD because the learning curve is not high since that's what they have used for a long time and it fits their needs.
- Cannot remember of a single federal project so they have not had to use MicroStation yet.

South Jordan - Jeremy Neilson, P.E. Deputy Engineer

- City uses AutoCAD because that is what they were trained in and it's what most of the industry uses.
- Had to hire a consultant because they could not use MicroStation.
 - It did not make much sense because UDOT had nothing to do with the local street.
 - Sees them doing more in-house design if they did not need to do projects in MicroStation.
- Have in general shied away from federal funded projects because of the strings attached and the MicroStation requirement.
 - But expect to ask for federal funds in the future.

West Valley City - Wendell T. Rigby, P.E.

- City uses AutoCAD because that is what they prefer.
- Sometimes when they receive CAD files from UDOT the design features and the links or cross-references get broken in the conversion.
- When they send files to UDOT they usually convert the files to a *.dgn (MicroStation) or send the AutoCAD file.
- Do not outsource drawings to be converted to *.dgn (MicroStation) format.
- When working with UDOT, they simply provide input to UDOT.

The responses obtained varied in depth and intensity of discomfort about the current AutoCAD/MicroStation conversion issues. However, the overall feeling and responses received was:

- Cities prefer working with AutoCAD for federally funded local projects.
- There is an increased cost when the project must be designed in MicroStation.
- They have had problems with the conversion.

5.3 Consultant Survey

Eighty-eight contractors and consulting firms that have previous experience working with UDOT were contacted and 32 responded to an on-line survey (see Appendix A). A summary of the responses to each question follows.

Question 1: What CADD program do you use?

AutoCAD and MicroStation were used by nearly every company that responded to the survey. Of the 32 companies, 16 used MicroStation exclusively, ten used AutoCAD exclusively, four used both MicroStation and AutoCAD, and two used other programs. A breakdown of the programs used is shown in Figure 6.

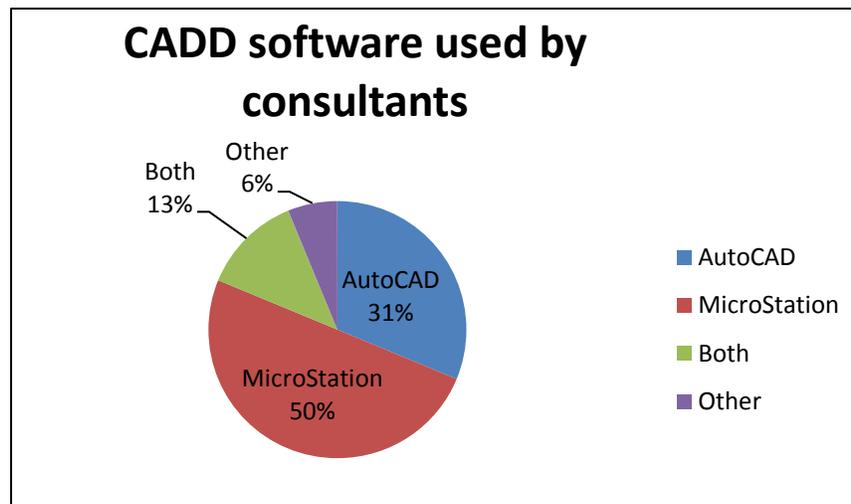


Figure 6: Consultant CADD Software

Question 2: What version of the CADD program do you use?

Most MicroStation users are now using MicroStation V8i to conform to UDOT standards. There were a few exceptions with users using MicroStation V8XM, MicroStation/J, and MicroStation 2004. There was more variance with the version of AutoCAD that was used. While AutoCAD Civil 3d 2011 was the most common, there were users using versions from AutoCAD 2007 to AutoCAD 2010.

Question 3: What format is the file in when you submit your projects to UDOT?

The majority of consultants responded that they submitted drawings to UDOT in the MicroStation (*.dgn) format. For contractors, it was far more common to submit drawings in Adobe's Portable Document Format (*.pdf). A breakdown of

the format with which responding consultants and contractors send their drawings to UDOT is shown in Figure 7.

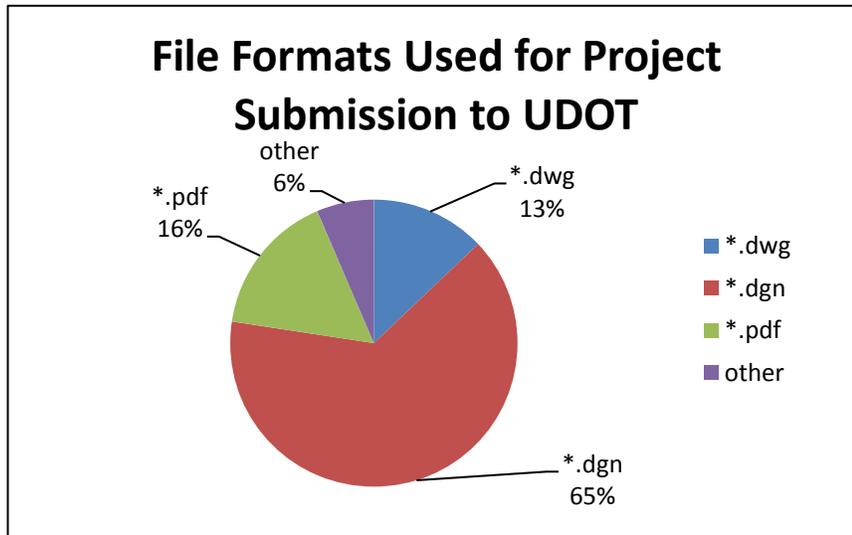


Figure 7: Consultant CADD Drawing Format

Question 4: Do you use another program to convert to MicroStation (*.dgn)?

The majority of companies did not use another program to convert drawings to MicroStation format. Four of the consultants do use the conversion capability of AutoCAD to convert file from the AutoCAD (*.dwg) format to MicroStation (*.dgn).

Question 5: Did you know that AutoCAD has an internal program that will convert the file to a *.dgn?

Nineteen companies responded “yes” and eight responded “no”, with the remainder stating that they were not aware of this functionality but are interested in more information.

Question 6: In what format did UDOT return your drawing?

All respondents reported that their drawings were either returned in MicroStation (*.dgn) format or in Adobe Acrobat (*.pdf) format. In phone interviews, it was the opinion of many consultants that they did not expect anything other than the

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MicroStation format as UDOT has indicated their requirement for the use of MicroStation. Many consultants stated their desire to conform to the expectations of any client with which they work.

Question 7: Did you have any file problems when you received your drawing from UDOT?

While most consultants and contractors that were surveyed did not respond to having any major file problems there were a few exceptions. These exceptions were primarily responses that related to coordinate system problems or minor line weight issues. Several of the consultants felt that the MicroStation platform had slightly greater problems producing accurate results with respect to coordinate systems and measurements than AutoCAD.

Question 8: Were UDOT recommendations clearly presented in the drawing?

Of the 32 responding consultants and contractors, 22 responded that they felt that UDOT clearly presented their recommendations in the drawings. Only five of the respondents indicated having difficulty in interpreting the recommendations that were presented.

For the most part, the consultants that submitted surveys and used MicroStation have had no major concerns receiving or submitting project drawings to UDOT. Some consultants that currently use MicroStation would not mind UDOT allowing them to use AutoCAD. The representative from Hatch Mott MacDonald stated, “UDOT needs to give up their dependency on MicroStation and allow consultants to use AutoCAD as well, Civil 3D has a ton of tools that are ahead of InRoads. I think the ability to decide which platform we use would be invaluable to some consultants.” He also states, “New graduates almost never have any experience with MicroStation, which requires companies have to spend a lot of additional time training graduates in MicroStation.”

The overall comments from the consultants that use MicroStation is if UDOT uses MicroStation to produce files, then consultants who want to do business with UDOT should use MicroStation and submit files in *.dgn format.

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Consultants that use AutoCAD indicated mixed feelings about UDOT's requirement of MicroStation (*.dgn) drawings for projects. A representative from Forsgren Associates disliked UDOT's use of MicroStation and stated, "If they were to ever switch to AutoCAD and Civil 3D they would find that there would be a larger pool of talent to work on their projects. This larger pool of talent could mean more competitive pricing, faster turnaround and I believe an overall increase in productivity." He also states that there is a need for UDOT to update their CAD standards and procedures and he often finds himself having to dumb-down his work because he uses tools that UDOT does not officially support.

Although some consultants would appreciate UDOT allowing them to submit files using AutoCAD Civil 3D because they can use powerful tools not offered in InRoads, the requirement for the *.dgn file format has not discouraged consultants from doing business with UDOT. Overall, the majority of AutoCAD users convert project files to the MicroStation (*.dgn) format using AutoCAD's built in converter, while others simply submit project files as *.pdfs.

5.4 Utility Company Survey

Eight Utility companies were surveyed, and two utilities responded to the survey (see Appendix A). One response came from Rocky Mountain Power in American Fork. On a scale of 1 (no issues) to 10 (major problems), they rated their issues to be 1. Rocky Mountain Power does not have the capability to convert files, and they are not aware of the latest conversion techniques but do not see an issue with UDOT creating standards concerning conversion issues.

The other response came from Integra Telecom in Salt Lake City. On a scale of 1 (no issues) to 10 (major problems), they rated their issues to be 1. Integra Telecom does not have the capability to convert files, and they are not aware of the latest conversion techniques but do not see an issue with UDOT creating standards concerning conversion issues.

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6.0 Summary, Conclusions, and Recommendations

In this research many different companies, agencies, and groups were contacted. The topics that the UDOT focus group discussed were bigger interoperability issues that must be addressed: utility companies use of AutoCAD, reasons for staying with Bentley, and the topics for this project.

Tennessee, Florida, and Washington DOTs were contacted because they use both AutoCAD and MicroStation programs. Some of the reasons for using both programs were to generate more submissions for jobs and not wanting to rely on one program. The Utah cities that were contacted said they use AutoCAD for the majority of their work. Some of the cities, like Provo and West Valley, use MicroStation as well because it is what UDOT uses. Many cities said that when they worked on a UDOT project, that they submitted their drawings in a *.pdf format.

The majority of the consulting companies that were contacted conform to UDOT standards by using MicroStation exclusively and a good portion of the remaining companies use both AutoCAD and MicroStation. When it came to the submission of the projects, 65% of the companies surveyed submitted projects in the MicroStation (*.dgn) format. The consultants indicated that they do not have any major problems with the submission of projects. On the other hand, the utility companies provided little to no help towards the study. Many attempts were made to contact them with no success.

This research highlighted some of the problems that arise when accepting plans from multiple platforms, beginning with an analysis of the challenges presented. Identifying the stakeholders that are involved when sharing CADD drawings and reviewing their input has brought better understanding of the desires and needs of UDOT as well as individuals with whom UDOT works. It is necessary to review all the challenges that are presented as well as the benefits that may be received by changing existing practices with regards to the format with which CADD drawings are shared and received. Because of these challenges and the opinions of the various stakeholders, it is not recommended to allow CADD files to be submitted in multiple formats at this time.

6.1 Interoperability between platforms

While the existing platforms do provide some ability to convert between AutoCAD (*.dwg) and MicroStation (*.dgn) formats, it can be concluded that these conversion tools are not currently sufficient to meet UDOT's needs. Ensuring that all the drawing data is accurately transferred when converting between platforms can be quite difficult. Special care must be taken to ensure that the correct files are present for conversion. Additionally, there is some difficulty in ensuring that units are transferred correctly between the two file formats. With the difficulties that arise when converting between the two platforms, it is not currently recommended to allow the submittal of files in both the *.dwg and *.dgn formats. These difficulties include: the difficult process of converting files properly and issues resulting from the difference in formats such as Template files and Seed files that vary between the two platforms. Too many potential problems exist if files in multiple formats need to be converted into MicroStation and conversion would require a large amount of additional time and monetary investments to overcome.

6.2 MicroStation Format Requirement

In reviewing the opinions expressed by consultants and contractors that work with UDOT, there is a definite interest in the use of AutoCAD to prepare drawings. This is primarily due to the reduced purchase and subscription costs as well as wide use of AutoCAD in varying industries. While there is a great desire for consultants to be able to submit files in the AutoCAD (*.dwg) format to UDOT, it is not a deterrent for companies in working with UDOT and their wishes to continue the use of MicroStation. Many consultants contacted expressed their desire to conform to any standard that the client may require and that, while the use of AutoCAD may be preferred, they have no issues in preparing drawings in MicroStation as UDOT requires.

6.3 Final Recommendations

It is not recommended that files be submitted in multiple formats because of the conversion issues and the pressure it would put on UDOT staff to accept these files. It is recommended to be mindful of the conversion issues that may arise as cooperation with other parties on projects such as utilities may expose the DOT to files that have been through a conversion process similar to that provided in AutoCAD. Understanding the issues that may exist with converted files could possibly save time and prevent potential problems.

In addition it is recommended that UDOT work with other DOTs to have Bentley provide Microstation to universities at reduced costs. This will help to create a workforce that is familiar with Microstation before they get to their positions with the DOT or with a consulting firm. This would lower costs of training to the DOT in the long term.

6.3 Future Research

While the current conversion processes are not fully adequate to facilitate the needs of UDOT, it may be beneficial to review the potential at a later time. Currently, there are indications that future conversions between the two platforms may be streamlined as there are continuing efforts between Bentley and Autodesk to provide better interoperability. If some of these issues are resolved, allowing plans to be submitted in both platforms may be possible in the future.

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Appendix A

Contained within Appendix A are the surveys that were sent to city engineers and officials, consulting companies, and utilities. The surveys for city officials, utilities, and consultant companies and are presented in **Error! Reference source not found.** and Figure 9, Figure 10 and Figure 11, and Figure 12 and Figure 13, respectively.



Do you use Auto CAD because it is cheaper or do you prefer it (compared to MicroStation)?

Does using AutoCAD cause issues when doing in-house design and when communicating with UDOT about it?

Do you do many joint projects with UDOT? If so, how do you exchange information?

Figure 8: Part 1 of 2 City Officials Survey

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Do you choose companies based on the software that they use (i.e. companies that use AutoCAD)?

Do you outsource drawing that need to be converted to MicroStation?

Federal projects on city roads are required to be in MicroStation Because UDOT is the project manager. How does this affect you?

Company Information

Company Name:

Company Address

Phone:

Email:

Any additional information that you think would be helpful to this project:

Submit

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Figure 9: Part 2 of 2 City Officials Survey



UDOT AutoCad/Microstation Interoperability Survey

USU is conducting a research study for UDOT regarding issues consultants who have previously worked with UDOT may have had when sending and receiving plans.

Please complete this survey by February 17, 2011. Thank you for your help!

What CADD program do you use?

- AutoCAD
- MicroStation
- Other:

What version of the CADD program do you use?

What format is the file in when you submit your projects to UDOT?

- *.dwg
- *.dxf
- *.dgn
- Other:

Do you use another program to convert to *.dgn?

- Yes
- No
- N/A

If YES, what program do you use to convert files?

Do you use a third party to convert files to *.dgn?

- Yes
- No
- N/A

Figure 10: Part 1 of 2 Utility Company Survey

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If YES, what third party do you use?

Did you know that AutoCAD has an internal program that will convert the file to a *.dgn?

- Yes
- No
- No, and I would like more information about it
- N/A

In what format did UDOT return your drawing?

Were UDOT recommendations clearly presented in the drawing?

- Yes
- No

Company Information

Name:

Company Address:

Phone:

Email:

Any additional information that you think would be helpful to this project:

Submit

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Figure 11: Part 2 of 2 Utility Company Survey

UDOT AutoCad/Microstation Interoperability Survey

Please complete this survey and select submit . Thank you for your help.

What issues have you seen when converting MicroStation (.dgn) files to AutoCAD (.dwg) files?

If UDOT and you were able to create standards that would help with the conversion issues, do you see cost and time savings with that?

- Yes, It could streamline the process and save a large amount of time
- Yes, but the time and savings would be minimal
- No, We don't see an issue.
- Other:

How big and detailed are the drawings you receive from UDOT? What type of drawings are they (3D, cross sections, ect)?

Are you familiar with the latest conversion techniques>

- Yes
- No
- NA

If Yes Please explain the conversion process you use.

Figure 12: Part 1 of 2 Consulting Company Survey

EVALUATION OF AN INDEPENDENT CADD PLATFORM FOR UDOT

From a scale from 1 to 10, how would you rate the issues you have had related to the current practice in receiving files?

1 2 3 4 5 6 7 8 9 10

No Issues Major Problems

Have you seen better conversion since UDOT switched to Microstation V8I?

- Yes
- No
- Hasn't really been an issue

Company Information

Company Name:

Company Address

Phone:

Email:

Any additional information that you think would be helpful to this project:

Submit

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Figure 13: Part 2 of 2 Consulting Company Survey