Trip Table Conversion How-To

This document provides basic information on preparing and converting trip tables used in four-step models to the format required by TRANSIMS programs. Zone-to-zone trip tables by trip purpose are converted to households, vehicles, and trips between activity locations by second of the day.

Revision History

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1.0 Assumptions and Prerequisites

This document assumes you has installed TRANSIMS Version 4.0.3 on a Windows or Linux computer system and understand the basic procedures and terminology for executing TRANSIMS programs.

The TRANSIMS software and documentation can be downloaded from http://sourceforge.net/projects/transims/files/ → software. Basic TRANSIMS procedures and terminology are addressed in the Installation and Testing How-To available in the documentation set.

This document also assumes that another software package is currently being used for regional travel demand forecasting and that trip table matrix files from that software package will be used as input to TRANSIMS. You should have a basic understanding of how to manipulate matrices

using traditional software, as well as trip table concepts, such as "production-attraction" and "origin-destination" formats. Knowledge of time-of-day modeling where "diurnal" patterns are used to split daily trips into periods of the day is also useful.

You will need to be able to review and edit data files using a standard text editor (e.g., vi, Pico, WordPad). Familiarity with software that can generate charts (e.g., Excel) is helpful in reviewing diurnal distribution curves.

1.1 Download Sample Datasets

This How-To document uses network and trip table information for Alexandria, Virginia. To download the Alexandria data to your computer or local area network, select http://sourceforge.net/projects/transims/files/ → test data → Alexandria 2007-12-14→ Alexandria.zip

You should create a directory with a name such as

c:\TRANSIMS\Alexandria (Windows)
/home/TRANSIMS/Alexandria (Linux)

and unzip the downloaded file to this directory.

The programs described in this document require data generated by the Network Conversion How-To and the Transit Network Conversion How-To case studies.

1.2 Activity Location Data

At a minimum, you need the Activity Location and Process Link files as input to the trip table conversion process. Activity locations are the points in the network where trips begin and end. They are associated with network links and are connected to parking lots using process links. Each zone can be associated with one or more activity locations. The modeler controls the spacing of activity locations on each link during the network conversion process.

In order to allocate trips to activity locations, each location must be associated with one of the traffic analysis zone numbers found in the input trip tables. For each trip in the trip table a unique household ID will be generated and associated with the starting activity location. If the trip requires an automobile, a vehicle is placed at the parking lot connected to the household activity location.

Activity locations can also include socioeconomic data, such as the number of households and various employment categories. If the user has provided these data, they can be used to proportionally distribute the trips to activity locations inside the zone. Otherwise, trips are uniformly distributed to the activity locations assigned to each zone.

2.0 Introduction to TRANSIMS Travel Demand

The TRANSIMS architecture is based on the time, duration, and location of each person's activities throughout the course of the day. Persons are associated with households so that the interrelationships of activities at the household level can be considered. Household composition is a useful predictor of the types of activities a given person is likely to make. The TRANSIMS software includes a Population Synthesizer to generate households of various compositions based on US Census Bureau information and growth forecasts. The Activity Generator is then used to assign activity patterns to those households and to locate the activities within the region. In this construct, travel becomes the mechanism by which a person moves from one activity location to another.

Because not all travel within a region is made by local household members, TRANSIMS also includes the concept of itinerant trips to capture the impact of those trips on network performance. Itinerant trips include trips made by persons from outside the region, trips made by persons passing through the region, and trips made by commercial vehicles within the region. The modeler includes these trips in the simulation through zone-to-zone trip tables and diurnal distribution curves. The software allocates the zone-based trips to activity locations within the zone and selects the time of day for the trip based on the user-defined diurnal distribution. A single-person household and a vehicle are created at the origin of the trip, and an activity for this person is defined at the trip destination. This means that itinerant trips can be modeled in exactly the same way as household-related trips.

The approach described in this document takes the concept of itinerant trips one step further. Instead of using the Population Synthesizer and Activity Generator to create households and activity patterns, the itinerant trip method is used to create activities for the person trips within the region. This allows the TRANSIMS Router and Microsimulator processes to be applied using standard trip tables produced by the regional travel demand forecasting model.

3.0 How to Prepare Trip Table Input Files

Trip tables are prepared using a regional travel demand forecasting software package (e.g., TP+, TransCAD, EMME/2). This document does not describe how to use those software packages to perform the required tasks (refer instead to the software user's guide for details on how to perform these tasks). This section describes the types of tasks that typically need to be performed to create the input data files required by TRANSIMS.

3.1 Origin-Destination Trip Tables

TRANSIMS simulates trips in origin-destination format and therefore requires trip table input files to be in that format. Most regional modeling procedures generate, distribute, and select travel modes using trips defined in production-attraction format. For example, home-based work trip tables typically include two trips between the home zone and the work zone as the production-attraction representation of a travel tour that starts at home in the morning and returns from work in the evening. Traditional modeling techniques convert these trips to origin-destination format prior to the traffic assignment process. This is typically done by creating a

corresponding trip table in attraction-production format (the transpose of the production-attraction table) and allocating appropriate percentages of the production-attraction and attraction-production tables to the origin-destination trip table for a given time period.

To input a trip table to TRANSIMS, the file needs to be exported to a tab-, space-, or comma-delimited file with at least three data fields (origin zone, destination zone, and number of trips). Many demand forecasting packages model fractional trips. Because TRANSIMS models individuals, fractional trips must be rounded before the trip table is exported, so that the trips can be input to TRANSIMS as integers. Keep in mind that a simple rounding may change the amount of trip demand input to TRANSIMS. An input trip table file will look something like the following:

```
ORG    DES    TRIPS
1      1      450
1      2      440
1      3      208
1      4      614
1      5      16
1      6      17
2      1      429
2      2      446
2      3      213
2      4      638
2      5      11
2      6      12
3      1      203
3      2      209
3      3      112
3      4      331
3      5      35
3      6      37
4      1      598
4      2      625
4      3      328
4      4      998
4      5      20
4      6      63
5      1      23
5      2      21
5      3      17
5      4      41
```

3.2 Trips by Trip Purpose and Time of Day

Time of day is an important consideration in deciding how to preprocess trip tables for input to TRANSIMS. Each trip will ultimately need a specific start time (a second of the day). The time-of-day probabilities distributions discussed in the next section are used to accomplish this task. The question that needs to be asked is, what is the best way to combine trip origins and destinations with time-of-day distributions in order to accurately replicate the traffic expected on the network by time of day? The answer depends on the confidence you place on various components of your regional modeling process and on the availability of observed data by time of day.

If, for example, data from a household survey can be used to generate a reasonable estimate of travel by trip purpose and time of day, it may be desirable to use these data to develop diurnal distributions and export trip tables by trip purpose. If, on the other hand, the only time-of-day information comes from traffic counts on major facilities, it may be better to work with the total origin-destination trips used for highway assignment and ignore trip purpose and trip orientation information that might be gleaned from production-attraction trips by trip purpose. If no time-of-day data are available, it may be best to use professional judgment about the general pattern of travel by trip purpose. This is likely to produce better time of day travel patterns than distributing highway assignment trip tables using a single diurnal distribution.

Several options for inputting trip table data into TRANSIMS are listed below:

- Daily production-attraction and attraction-production trip tables by trip purpose
- Daily origin-destination truck and external trips
- AM peak, PM peak, and off-peak trips by trip purpose and travel mode (high-occupancy vehicle, transit, etc.)
- Total origin-destination AM peak, PM peak, and off-peak vehicle trips
- Trips by vehicle type, area type, geographic area, and/or trip length

3.3 Transit and Park-and-Ride Trips

Each trip table input to the trip table conversion process is assigned to a single travel mode and vehicle type. Separate trip tables for single-occupancy autos, high-occupancy autos, trucks, and transit trips will enable the modeler to make these distinctions. Transit trips will also need to be separated into transit-walk access and transit-drive access (e.g., park-and-ride) tables to capture the important differences in these trips within the TRANSIMS process. Transit-walk trips are further complicated by the fact that transit service is not provided to all areas at all times of day. To address these time-of-day issues, you may wish to subdivide the transit trips into market areas that have similar service levels by time of day.

Park-and-ride trips are treated as a special case within the trip table conversion process and within the TRANSIMS software. Since TRANSIMS tracks the vehicles as well as the individuals, it must have a vehicle available at the beginning of the driving portion of a park-and-ride trip. For an outbound park-and-ride trip (one that starts at home), the vehicle is located at the parking lot attached to the home activity location. The vehicle is then parked at the park-and-ride lot that minimizes (with constraints) the combined travel impedance of the drive leg and the transit leg.

The inbound (i.e., return) park-and-ride trip is more difficult. In this case, the vehicle must be parked at the park-and-ride lot so it can be picked up after the traveler completes his or her transit leg. In a tour-based application, the traveler returns to the parking lot where the vehicle was parked during the outbound trip. The trip table conversion process simulates this behavior by creating round-trip tours rather than independent trips for park-and-ride trip tables. The input trip table should be in traditional production-attraction format for this to work. The software divides the trips in half and assigns one trip between an activity location in the production zone

and an activity location in the attraction zone. These two activity locations are then used for the return trip. Both trips are assigned to the same household traveler and vehicle. The time-of-day distribution is based on the time schedule of the outbound trip. The schedule for the return trip is based on the activity duration and the estimated arrival time of the outbound trip.

Take a simple work activity accessed using a park-and-ride mode as an example. The input park-and-ride trip table in production-attraction format includes two trips between the home zone and the work zone. The conversion software takes one of these trips and assigns it to start at an activity location in the home zone based on the associated diurnal distribution. The trip ends at an activity location in the destination zone. A vehicle is generated for the trip and parked at a parking lot attached to the home activity location. The mode for this trip is set to park-and-ride outbound. This traveler is then assigned a second trip that starts at the work activity location and ends at the home activity location. The mode for this trip is set to park-and-ride inbound. The start time for this trip is set by the arrival time at work plus a modeler provided activity duration (e.g., 9 hours).

4.0 How to Prepare Diurnal Distribution Files

Since TRANSIMS models trips on a second-by-second basis, the trips included in the input trip tables need to be distributed to a specific time of day for use within TRANSIMS. The **ConvertTrips** program will assign an exact start time randomly for all trips within each period defined in the diurnal distribution.

This section discusses a number of considerations in generating diurnal distribution files.

4.1 Diurnal Distribution Files

Diurnal distribution files, or trip time files, are tab-, space-, or comma-delimited text files with at least three data fields (start time, end time, and one or more distribution fields). The first two columns of the file define the starting and ending time of the time period and can be defined in hours, seconds, or clock time units (e.g., 18:30). The third column contains a number that represent the time period's share of trips. If the shares across all time periods do not sum to 1.0, the shares are normalized so they do sum to 1.0. This means that the values represent the relative probability of a trip within the time period given the sum of all values in the distribution. If additional share columns are included in the file, special processing options are required to use these fields.

A sample diurnal distribution file is show below:

```
START    END      SHARE    SHARE2
0        0.5      25.45    9.752
0.5      1        13.125   2.872
1        1.5      6.294    0.76
1.5      2        3.109    0.16
2        2.5      2.165    0.104
2.5      3        2.522    0.864
3        3.5      3.598    3.288
3.5      4        5.104    6.16
```

```
4         4.5       7.061     6.392
4.5       5         9.751     5.728
5         5.5       13.481    9.224
5.5       6         18.352    16.896
6         6.5       24.276    24.448
6.5       7         31.326    29.832
7         7.5       40.141    35.272
7.5       8         52.138    43.584
8         8.5       69.282    53.792
8.5       9         93.3      70.352
9         9.5       124.467   103.88
9.5       10        160.692   154.768
10        10.5      197.937   215.072
10.5      11        232.097   259.208
11        11.5      260.875   271.192
11.5      12        283.861   279.352
12        12.5      300.783   311.032
12.5      13        309.963   338.96
13        13.5      309.026   338.408
13.5      14        298.018   324.912
14        14.5      282.986   324.488
14.5      15        276.297   175.244
15        15.5      290.935   193.956
15.5      16        331.377   213.652
16        16.5      388.847   466.2
16.5      17        445.601   504.448
17        17.5      483.867   539.088
17.5      18        492.074   564.248
18        18.5      467.304   561.008
18.5      19        416.863   522.44
19        19.5      357.315   237.468
19.5      20        306.732   214.936
20        20.5      273.393   193.676
20.5      21        251.44    338.592
21        21.5      228.189   283.504
21.5      22        195.435   214.24
22        22.5      154.27    144.552
22.5      23        111.574   88.184
23        23.5      74.089    50.464
23.5      24        45.282    25.416
```

Each trip table needs a distribution file associated with it. The same file can be used for different trip tables. If the file includes multiple data fields containing diurnal information, you can specify which data field should be used for each trip table. Since trip tables can also be limited to specific time periods (e.g., AM peak), you can specify the range of time periods (i.e., rows) that are included in the distribution for a given trip table. This allows a single diurnal distribution file to be used when trip tables are provided for multiple time periods.

4.2 Trip Start, End, or Mid Times

You can apply the diurnal distributions based on the start time of the trip, the arrival time of the trip, or the midpoint of the trip. Each trip table can have a different time-of-day control point. For example, you may choose to control the time of day for home-to-work trips based on the arrival time at work. In such cases, longer work trips will be scheduled to start earlier than shorter work

trips. Conversely, you may wish to control the time of day for work-to-home trips based on the departure time from work (i.e., the trip start time). Other trips may not have trip end constraints.

The decision about how to prepare diurnal distribution files and certain trip tables will partially depend on the control point decision. It should also be noted that TRANSIMS uses the start time of the trip to build paths and simulate travel. If an arrival time control point is used, the start time is calculated based on the estimated travel time between the origin and destination activity locations by travel mode. This calculation is also controlled by user parameters, but the parameters do not change over the course of the day. In other words, the predicted travel time used to determine the trip start time is not affected by traffic congestion at different times of day. You may choose to split your trip tables into peak and off-peak periods and specify different average speeds for each period using the `AVERAGE_TRAVEL_SPEED_#` control keys in order to more accurately replicate the traffic conditions of each time period.

4.3 Distribution Smoothing

People who respond to home interview surveys or other questionnaires are not very accurate in their perception of travel time of day. They almost always round off their time of day response to the nearest 15-minute or half-hour increment. This often results in diurnal distribution curves that have large spikes on the hour or half hour and relatively low values in between. When a distribution like this is applied within TRANSIMS, trips surge onto the network at regular intervals, resulting in congestion bottlenecks at load points that do not exist in the real world.

To avoid this problem, we recommend you smooth the diurnal distribution curves prior to input to TRANSIMS. A utility program called **SmoothData** is provided to assist in this process. This program applies multiple iterations of a moving average technique to help minimize the impact of time-of-day spikes on the trip table conversion process. You can review the input and output distribution files using a chart tool such as Excel to judge if the smoothing is reasonable.

A sample distribution file called “HBO_PA.txt” is provided in the survey directory to demonstrate this process. This file represents the raw home interview survey responses by 15-minute increments for home-based other trips in the production-attraction direction of travel. The control file “SmoothData.ctl” in the control directory can be used to smooth this data for input to TRANSIMS. The file includes the following keys.

```
INPUT_DATA_FILE_1              ../survey/HBO_PA.txt
INPUT_DATA_FORMAT_1            TAB_DELIMITED
OUTPUT_DATA_FILE_1             ../survey/HBO_PA_Diurnal.txt
OUTPUT_DATA_FORMAT_1           TAB_DELIMITED

SMOOTH_FIELD_NUMBER            3
SMOOTH_GROUP_SIZE              3
PERCENT_MOVED_FORWARD          20.0
PERCENT_MOVED_BACKWARD         20.0
NUMBER_OF_ITERATIONS           10
CIRCULAR_GROUP_FLAG            true
```

The keys define a 10-iteration (NUMBER_OF_ITERATIONS) moving average involving three (SMOOTH_GROUP_SIZE) 15-minute time periods (SMOOTH_TIME_INCREMENT) with 20 percent forward (PERCENT_MOVED_FORWARD) and backward shifts (PERCENT_MOVED_BACKWARD) on the third column (SMOOTH_FIELD_NUMBER) of the HBO_PA.txt file. The program can be executed with one of the batch file found in the control directory:

SmoothData.bat (Windows)

Open the two data files (HBO_PA.txt and HBO_PA_Diurnal.txt) in the survey directory using a program such as Excel and compare the before and after graphs of the SHARE field to illustrate how the time of day distribution has been smoothed.

5.0 How to Convert Trip Tables to TRANSIMS

Given a set of input trip tables and diurnal distribution curves, the **ConvertTrips** program allocates the zone-to-zone trips to travel between specific activity locations by second of the day. This section describes how to set up and run the **ConvertTrips** program.

5.1 Overview of the ConvertTrips Program

The **ConvertTrips** program converts one or more zone-based trip table files to TRANSIMS activity, household, population, and vehicle files. The trips are allocated to activity locations within the corresponding zones, and trip start and end times are assigned based on a time-of-day probability distribution and the estimated travel time between the origin and destination given the specified travel mode. A new one-person household is created for each trip and placed at the origin activity location. If the trip requires a vehicle, a new vehicle is also created and placed at the parking lot attached to the origin activity location.

For each trip table, you can specify the following:

- diurnal distribution and time control point,
- time-of-day limits or ranges,
- data fields to weight the allocation of trips to activity locations within the origin and destination zone,
- trip purpose,
- travel mode,
- average travel speed,
- vehicle type and subtype, and
- trip table adjustment factors.

For advanced applications, you can also develop a program script to assign different diurnal distributions to specific origin or destination zones. This capability can be used to apply a different diurnal distribution to trips in a given area or between specific zone combinations.

5.2 The ConvertTrips Control File

A sample control file for the **ConvertTrips** program is provided in the control directory. The file "ConvertTrips.ctl" is a text file that can be reviewed and edited using a standard text editor. A subset of the file records is listed below.

```
TITLE                          Convert Alexandria Trip Tables
DEFAULT_FILE_FORMAT            TAB_DELIMITED
PROJECT_DIRECTORY              ../

#---- Input ----

NET_DIRECTORY                  ../network
NET_ACTIVITY_LOCATION_TABLE    Activity_Location_2
NET_PROCESS_LINK_TABLE         Process_Link_2

#---- auto HBW SOV trips ----

TRIP_TABLE_FILE_1              trips/HBW_SOV_PA.txt
TRIP_TIME_FILE_1               survey/HBW_SOV_PA_Diurnal.txt
TIME_CONTROL_POINT_1           DESTINATION
ORIGIN_WEIGHT_FIELD_1          NULL
DESTINATION_WEIGHT_FIELD_1     NULL
TRIP_PURPOSE_CODE_1            1
TRAVEL_MODE_CODE_1             2
AVERAGE_TRAVEL_SPEED_1         15
VEHICLE_TYPE_1                 1
VEHICLE_SUBTYPE_1              0

#---- HBW transit trips ----

TRIP_TABLE_FILE_7              trips/HBW_TRN_PA.txt
TRIP_TIME_FILE_7               survey/HBW_TRN_PA_Diurnal.txt
TIME_CONTROL_POINT_7           DESTINATION
ORIGIN_WEIGHT_FIELD_7          NULL
DESTINATION_WEIGHT_FIELD_7     NULL
TRIP_PURPOSE_CODE_7            1
TRAVEL_MODE_CODE_7             3
AVERAGE_TRAVEL_SPEED_7         10
VEHICLE_TYPE_7                 4
VEHICLE_SUBTYPE_7              0

#---- Output ----

TRIP_FILE                      activity/Trip
POPULATION_FILE                household/Population
HOUSEHOLD_FILE                 household/Household
VEHICLE_FILE                   vehicle/Vehicle

STARTING_HOUSEHOLD_ID          1
STARTING_VEHICLE_ID            1
TIME_OF_DAY_FORMAT             SECONDS
MINIMUM_TRAVEL_TIME            180
RANDOM_NUMBER_SEED             14445
```

This example shows two trip table groups. The first table relates to auto trips, and the second table relates to transit-walk access trips. All of the keys with the same "_#" extension control the processing for a trip table group. Each group includes a trip table file (`TRIP_TABLE_FILE`) and a

diurnal distribution file (TRIP_TIME_FILE). Since both groups are associated with work trips, their time schedule is controlled at the destination (TIME_CONTROL_POINT). Including NULL for the ORIGIN_WEIGHT_FIELD and DESTINATION_WEIGHT_FIELD means that weighting factor from the Activity Location file will not be used. In this case, all activity locations are assigned equal weight. The code numbers used for TRIP_PURPOSE_CODE, TRAVEL_MODE_CODE, VEHICLE_TYPE and VEHICLE_SUBTYPE are defined in the software documentation. These examples tell TRANSIMS that these are work trips, with auto and transit-walk access modes, and standard autos and transit buses. The average travel speed (AVERAGE_TRAVEL_SPEED) for auto trips is 15 meters per second and transit trips is 10 meters per second.

5.3 Reviewing the Results

The **ConvertTrips** program can be executed using the batch files included in the control directory:

RunEntireCase.bat (Windows)

The batch file will run the full case. A batch file can be created that only runs the first four steps of the full case, specifically TransimsNet, IntControl, TransitNet, and ConvertTrips by deleting the subsequent steps from the batch file and saving as a new file. The printout file "ConvertTrips.prn" will be created by the process, along with the new data files stored in the activity, household, and vehicle directories. The printout file will include warning messages about any trips that could not be assigned and zones that do not include two or more activity locations. If no activity locations are assigned to a given zone, none of the trips to or from that zone can be simulated within TRANSIMS. If a zone has only one activity location, none of the intrazonal trips can be simulated. You will typically want to review each zone included in the warning list to determine if one or more activity locations can be reassigned to the zones in question.

Overlaying a zone boundary file on top of the ArcNet shapefiles in a GIS program is the easiest way of identifying activity locations that can be reassigned to each zone. A zone boundary shapefile for the Alexandria network is included in the network/arcview directory. The zone shapes developed for Alexandria are relatively uniform and logical. If the zone shapes were significantly distorted by irregular natural or manmade barriers, it may be advisable to perform a point-in-polygon join of activity locations to zone boundaries using GIS tools. This procedure can refine the zone number assigned to each activity location and thereby improve the allocation of zone-based trips to network access points.

6.0 Troubleshooting

If a significant number of trips are not converted, the problem is usually caused by data problems in the activity location file. It might be a lack of activity locations assigned to a given zone or origin or destination distribution weight fields that contain mostly zeros. If all of the activity locations within a zone have distribution weights of zero, this has the same impact as having no

activity locations within the zone. Reviewing the zone and distribution weight fields in the activity location file will solve most common problems.

You should be cautious about the distinction between activity locations and transit waiting areas. The **TransitNet** program adds locations to the activity location file that should only be used as waiting areas for boarding transit. By default, these activity locations have zone and data fields initialized to zero. This means they will not be used by the trip table conversion process. You should avoid adding a zone number or distribution weights to these activity locations, which are typically connected only to transit stops and therefore do not provide a connection to a parking lot. Since auto-related trips need access to a parking lot at the origin and destination activity locations, assigning auto trips to a transit waiting area will generate errors. For this and other reasons, it is often advisable to apply the **ConvertTrips** program to an activity location file that was generated prior to adding the transit network.

Trips assigned to external stations also require some attention. This is particularly true if the external station is a freeway represented as a pair of one-way links. If both the inbound link and the outbound link have activity locations assigned to the same zone, it is likely the procedure will generate trip interchanges that cannot be routed. For example, the Router will not be able to build paths with origins attached to the outbound link or destinations attached to the inbound link. You can anticipate or correct this problem by adjusting the distribution weights assigned to each activity location. By setting the origin weight for the outbound activity location to zero, no trips will use this location as a trip origin. Similarly, by setting the destination weight for the inbound activity location to zero, no trips will use this location as a trip destination.

7.0 Frequently Asked Questions

How do I update the zone numbers in the activity location file?

> Using a GIS tool like ArcGIS is a logical method for updating zone numbers. The process can be relatively easy if a zone boundary shapefile can be overlaid on the network and activity location points. You can then manually edit the activity location records based on visual assessments or attempt a spatial join between the activity location and zone boundary files. The success of the spatial join approach depends on the relative spatial accuracy of the network and boundary files. If the boundaries do not line up well with the network links, point-in-polygon joins can cause undesirable distortions. The TAZUpdate and CoordMatch programs can assist with this process. For more information about the capabilities of these programs, please refer to the corresponding program documentation.

How do I add socioeconomic data to the activity location file?

One method is to read the activity location file into a spreadsheet program like Excel and add several data fields (i.e., columns) with the socioeconomic data. This assumes you have a way of relating activity locations to zones or subzone geography. GIS tools can help with this. The TRANSIMS suite also includes several utility programs to assign or allocate data from zone or block group-based files to activity locations. The ActivityCalc and ActivityMap programs can assist with this process. For more information about the capabilities of these programs, please refer to the corresponding program documentation.