Comparison between Softcopy (DPW) and Analytical Systems (you decide)

Topic	Softcopy	Analytical
Image source	By digital camera or scanned negatives/ diapositives with scanning currently being predominantly used because of the cost of digital cameras although these are becoming more available. Negatives are mainly scanned directly thus eliminating the need for diapositives and the cost of scanning is therefore offset against that of producing a diapositive for an Analytical machine. There are many scanning bureaus available and a company should only invest in a geometric scanner if they have many (at least above 15 in our opinion) Softcopy Systems. The time taken to scan the images is therefore also not an issue as this is included in the price of the scan. Transport of the data is nowadays generally done by delivery of a hard drive to the bureau and retrieval of the drive(s) once complete. It is also often unnecessary to produce photo prints because images are fully visible in the Softcopy System.	Diapositives are produced from the original negatives. Photo prints are virtually always also made because it is difficult to reference detail in the images once the diapositives are placed in the Analytical System.

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<tr><th>Topic</th><th>Softcopy</th><th>Analytical</th></tr>
<tr><td>Image storage</td><td>Any electronic media e.g. hard drive, CD, tape streamer. Physical space requirement is therefore minimal. Off-site storage (possibly even a backup) is therefore simple. Some sample file sizes are listed but these can be considerably compressed with various compression techniques (both lossy and lossless).
<table>
<tr><td>Pixel size in microns</td><td>Disk space in Megabytes for grey scale</td><td>Disk space in Megabytes for 24 bit colour</td></tr>
<tr><td>12.5</td><td>320</td><td>960</td></tr>
<tr><td>17</td><td>172</td><td>516</td></tr>
<tr><td>21</td><td>114</td><td>341</td></tr>
<tr><td>25</td><td>80</td><td>240</td></tr>
<tr><td>32</td><td>49</td><td>147</td></tr>
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Here it should be remembered that a 73 Gigabyte hard drive costs around $300 (U.S.). Approximately 228 grey scale and 76 colour images can therefore be stored on a hard drive when scanned at 12.5 microns without any compression. Drive sizes are also continually increasing and becoming less expensive and most companies choose to scan at larger pixel sizes (e.g. 17 micron) because the accuracy improvement is minimal.</td><td>Negative film as well as 230mm * 230mm diapositives. Large fire-proof areas need to be provided for storage.</td></tr>
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Image viewing	The quality of the image is directly related to the quality of the negative and the scan resolution. Here the user has control over the pixel size but a very small pixel size results in large images. It therefore remains for the client to decide on the necessary accuracy but scans of 12.5 micron resolution yield accuracies within that expected from photogrammetry e.g. a planimetric accuracy of 0.04m at a scale of 1:5000. The same scale image scanned at 25 micron yield accuracies around 0.09m. These are simply guidelines as higher accuracies can be achieved by careful interpolation. Scanning at pixel sizes smaller than 12.5 micron is not recommended as the accuracy improvement is negligible. There are no lenses involved in viewing an image on a computer screen so no added distortions are possible. The size of the floating marks also effectively reduce (visually they appear the same size) when zooming in. This means that each pixel can easily be interpolated by a factor of at least 5 as each pixel can be zoomed in to occupy the whole monitor if required although this would be “over the top”.	The quality of the image is directly related to the quality of the negative and the creation of the diapositive from that negative. The most important physical property of a film in determining resolution is the size distribution of its silver halide grains (larger grains produce poorer resolution). However smaller grains (increased resolution) require longer exposure times. The trick is therefore to find the correct balance. The resolution of any lens-film combination is no better than its lowest rated component of which some are listed: • Illumination intensity. • The type of filter used. • Vibration of the camera. • Atmospheric conditions • Image motion during exposure. • Object contrast From this it can be seen that even if a film is capable of a resolution of 10 microns, numerous factors can negatively influence this accuracy. Analytical Systems have finite zoom ranges. Even if the Analytical System were capable of zooming in by a factor of 20, a 10 micron feature would still only be 0.2mm in size. I don’t know how your eyes are but mine struggle to distinguish between a 0.2mm **dot** and a 0.4mm **dot** on a piece of paper. Remember that floating mark sizes are around 20 microns. Most systems are also only accurate to 3 microns (encoder and servomotor limitations). The accuracy of the optical path of the Analytical System is also an influencing factor. From the above it can be seen that an image scanned at 12.5 micron is very close to the limitations of the external influences inherent in aerial photographs.
Camera distortions	Catered for in software	Catered for in software

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Inner (interior) orientation	• Done once for each image regardless of how many models the image falls in. • The inner orientation is digitally stored and always instantaneously available at any future date i.e. it need **never** be done again even if the model is revisited many years later. • Automatic inner orientation by autocorrelation is very successful and accurate. This means that literally hundreds of inner orientations can be done in short periods with absolutely no user intervention.	• Must be redone each time an image is removed from the machine. • If the machine does not cater for base in/out conversion then each images inner orientation **must** be measured twice. • Each time a new model is set up an inner orientation **must** be done. • Every fiducial point in each image must be measured manually by the user.
Exterior orientation	• Points are "driven" to instantaneously with absolutely no delay regardless of the distance between the points. • Infinitely variable zoom ratios are available at the touch of a button right from the full image (or smaller if required), down to a factor of 1 to 1 (or further in if required). Note: 1 to 1 denotes that 1 image pixel occupies 1 screen pixel on the monitor. • Superimposition is available so ground control points can be seen simultaneously with the image. • Automatic relative orientation by autocorrelation is available. Although not always 100% successful users can exercise control over the points and edit/delete any undesirable points. Relative orientation is therefore **to a large degree** streamlined.	• Servomotors drive the plates (images) and therefore a reasonable delay is inherent when moving between points. • Zoom in/out is machine dependant but it is unlikely that systems will offer a full view of the image. • Very few systems (if any) offer superimposition. • No automatic measurements are available.

Topic	Softcopy	Analytical
Aerial Triangulation	• Model and strip connections can be done automatically using autocorrelation. Here again full control is available to identify and eliminate "bad" points although often the software will identify and eliminate these points internally. • "Bad" points can be re-measured instantaneously without the need to redo the inner orientation regardless of which model the point falls in. This represents a considerable saving in time particularly on large jobs. • uSMART allows the user to click on a point in the aerial triangulation computation routine (bundle block adjustment) and the required images, model and point is instantaneously loaded/activated for immediate re-measurement. This process of measure, compute, measure compute etc can be done as many times as required until the desired residuals are achieved. • uSMART also offers a "Navigator" routine which allows numerous images to be viewed simultaneously and measurements to be done interactively "across" as many models and strips as required.	• No automatic procedures are available. • Each potentially "bad" point requires the re-installation of the diapositives in the machine with the necessary re-measurement of the fiducial points (inner orientation). • It is not possible to set up dynamic interaction between the bundle block adjustment program and the Analytical machine because only 2 images are available at a time.

Topic	Softcopy	Analytical
Vector Mapping	A Softcopy System functions virtually identically to an Analytical System when mapping features but uSMART offers many advantages (some are listed below): • Mapping features across models. It is often desirable for a feature to be continuous (e.g. for GIS purposes). In uSMART this is easily achievable because models can be changed/ activated instantaneously even whilst busy with a feature. If, for example, the road edges are urgently required, these can be mapped to completion across as many models as the features cover with absolutely no negative speed impact and quite probably faster. • uSMART offers a totally integrated system. The mapping is done on the same computer on which the Softcopy System resides and indeed is a complete comprehensive system where snapping, “driving”, superimposition etc is all integrated into one. • uSMART also offers the feature of dynamic correlation. This means that while the operator moves the floating mark in the X and Y directions, the floating mark is automatically “held” on the ground or put another way, the heights are automatically computed and output **without** the user needing to adjust the Z component.	• It is not possible to map features across various models as this would mean re-setting up the model for each feature. This means that considerable editing needs to be done to create continuous features for GIS purposes. Work is therefore confined to a model by model basis with no prioritisation of features possible. • Most Analytical Systems have a separate computer (or processing system) to the mapping computer. This means that separate hardware and software (stereoplotter connection and mapping software) needs to be purchased. • It is not possible to offer dynamic correlation in an Analytical System because no raster images are available.

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Digital Elevation/ Terrain Models (DEM or DTM)	Let's take the worst-case scenario where the terrain is just so bad that autocorrelation does not work at all although this virtually never happens for a complete project. This means that a "manual" DEM would need to be captured. You are therefore no worse off with a Softcopy System when compared to an Analytical System. However with uSMART you **still** have the following advantages: • The points will be driven to instantaneously with absolutely no delay required to accelerate, move at full speed, and decelerate, as necessary with Analytical Systems. • The surrounding points (also features and break lines) can be observed stereoscopically whilst capturing the DEM. By using this superimposition ability, unnecessary points can be skipped **without** removing ones eyes from the stereo view. • Dynamic correlation can be activated so points that correlate correctly can just be accepted by pressing a button. Now let's see how, in uSMART, user control can result in thousands (or millions) of highly accurate points being generated in minutes, **across as many models as required** when using autocorrelation. • Specification of the minimum allowable correlation factor. • Utilisation of a "growing TIN" method whereby each point is checked against a dynamically growing surface to ensure that it lies within user tolerances. In this way gross errors are eliminated **and** features such as tops of trees etc are not correlated (if specified.) • Specification of as many **exclusion** areas as required. • Specification of as many **inclusion** areas as required. • Specification of distance tolerances from structures (e.g. houses, bridges etc) as well as other already captured points, break lines etc.	The Analytical System can only offer the manual capture of a DEM whereas the Softcopy System offers both manual and automatic. Drive times between points are slower so a DEM takes considerably longer than when utilising a Softcopy System

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Orthophotos	In a Softcopy System this is one of the areas where the **minimal** amount of user intervention is required. It literally requires the definition of the orthophoto areas, the specification of output file names and the touch of a button. Let's look at the advantages of the uSMART Softcopy System: • Orthophoto area specification can be accomplished manually or automatically or via a combination of the two. Areas are typically specified around fiducial points to minimise relief distortion. • Orthophotos can be generated for as little as one image to as many as the whole project. No user intervention is required once the process is started. • The source images are already available so no further scanning is required. • **All** TIN data is utilised which typically includes captured features e.g. rivers, banks etc. This ensures that raster data and vector data is absolutely perfectly geometrically aligned. • Output orthophoto resolution can be to any pixel size required with the added advantage of enhancing the image quality with "Bilinear" or "Cubic Convolution" methods. • Orthophotos can be generated at various resolutions as many times as required and at extremely fast speeds. • The individual orthophotos can be balanced and feathered at the same time they are generated. • All the necessary software is included in the system e.g. for display etc.	There are not many Analytical Systems that offer orthophoto production as part of the system. There are however distinct disadvantages when utilising a system which does offer this capability: • The definition of the area to be covered needs to be done on an individual basis as precise coverage is not known for adjoining models. • Each orthophoto is individually generated so the Analytical System is fully occupied between models for relatively long periods. This means that vector data capture is dormant for these periods. A batch process is not available because images have to be removed and new ones inserted into the machine for each orthophoto. • No scans are available to work with. • TIN data is either from a captured DEM, from data output from the mapping system, or a combination of the two. It is often necessary to "feed" data back into the system from an external mapping application by utilising ASCII files. This makes the usage of **all** points a difficult task. Utilising neighbouring data is often difficult as often these models have not yet been mapped. • Generally lower resolution scans are opted for to save time. • Balancing and feathering on the fly is not an option because not all the images are captured simultaneously. • Additional software needs to be purchased for further processing of the images.
Output	With uSMART, a total solution is supplied i.e. from raw data to output of a final hardcopy or digital file with title block etc. No other software needs to be purchased.	We are unaware of any Analytical System offering a total solution i.e. additional software needs to be purchased often from a different supplier.

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Maintenance	Only a PC (typically 1GHz or faster) is required for the uSMART Softcopy System therefore only the computer needs to be maintained at minimal cost. Relocation of the system only requires a strong back for a relatively large monitor e.g. 19 or 21 inch.	There are many moving parts and optical systems in an Analytical machine. These require relatively expensive maintenance on a regular basis and repairs can be time consuming and costly. Relocation of the system is often very expensive with recalibration nearly always a prerequisite.
Price	The price of the uSMART Softcopy System is at least one fifth (1/5) of that of any analytical system we are aware of. We are also able to offer a sliding scale discount structure down to 50% of the first purchase price once 10 copies have been purchased.	Even the most attractively priced systems are costly and it is very unlikely that a supplier will offer a 50% discount because of the inherent hardware costs of the system.

Conclusion

It can be seen that the new 3rd generation of stereoplotters are truly accurate, efficient and cost effective systems. Too often comparisons are made between Analytical machines and old technology Softcopy Systems that have not kept abreast of hardware changes.

At SmartTech we ensure that we are always at the cutting edge of technology and our Softcopy System is an example of this philosophy. Many of our existing and new clients are replacing Analogue and Analytical Systems with our Softcopy System. Some are even replacing existing Softcopy Systems with the uSMART Softcopy System.

Why not put us to the test? Send us an e-mail and we will send you a list of clients who can give you their opinion on our system.